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BRITISH ENGINEERING STANDARDS ASSOCIATION

Papers on Standardization Work of This Important Association, with Special Reference to Screw Threads, Screw-Thread Gages and Tolerances

IN view of the standardization work in process by the Screw-Thread Commission of the United States Department of Commerce, the Machine-Shop Session of the Annual Meeting on Wednesday, December 4, will be devoted mainly to the production and testing of screw gages and standardization work in this connection. The work of the British Engineering Standards Association is reviewed in the following papers and a paper by Frank O. Wells, on the production of gages, is also given in this number. In the November issue appeared a paper by H. L. Van Keuren of the U. S. Bureau of Standards on methods of testing and standardizing gages.

SUMMARY OF THE WORK OF THE ASSOCIATION

By C. le Maistre,[1] London, England

THE insistent demand created by the war for the maximum output of manufactured material in the minimum of time has naturally brought to the fore those means by which economy in production can be effected, and in this way standardization is coming into its own. Indeed, standardization in the engineering world has become almost a word to conjure with, but like all good things, it must be taken in moderation, and the standards recommended must, by a process of periodic revision, be kept abreast of invention and progress; otherwise there is the danger of standardization becoming crystallization.

It may fairly be said that the primary objects of standardization are to secure interchangeability of parts, to cheapen manufacture by eliminating the waste of time and material entailed in producing a multiplicity of designs for one and the same purpose, and also to expedite delivery and so reduce maintenance charges and stores.

Seventeen years ago, however, neither the necessity nor the value of work of this character and still less its intimate relation to economy and speed of production was at all generally recognized, and it was to remedy the chaotic state of things then existing in the engineering industry of Great Britain that the late Sir John Wolfe Barry, K. C. B., F. R. S., in 1901 took the initial steps, when he brought the subject to the notice of the Council of the Institution of Civil Engineers, which resulted in the formation of the British Engineering Standards Committee.

From its inception certain definite principles have governed the work of the Committee, amongst which may be placed in the forefront the community of interest of producer and consumer, which is, in fact, the corner stone of the organization. It was also realized that the Committee should not be an academical body, but an industrial organization in the closest touch with practical requirements and modern scientific knowledge and discovery; that it should only undertake standardization to meet recognized wants, and then only at the request of the principal interests concerned; that it should confine itself to setting-up standards, leaving it to the user to satisfy himself by inspection and supervision that the standards were being adhered to; and, most important of all, that periodic revision of the standards should be undertaken so that improvements might be incorporated, the various industries thus being prevented from becoming stereotyped and their methods hidebound.

From the small nucleus of seven members who formed the original Committee, a far-reaching organization has developed with some 160 committees, sub-committees and panels, including in all over 900 members and dealing under one central authority with standards relating to practically the whole field of engineering. Thus for many years past, the British Engineering Standards Association, as it is now called, has provided the neutral ground upon which the producer and the consumer, including the technical officers of the large spending departments of the Government and the great classification societies, have met and considered this subject of such vital interest to the well-being of the engineering industry of the country.

To the observance of the democratic and progressive principles outlined, coupled with the devoted labor of its members freely giving their time and experience to the work, often at great personal expense and inconvenience, may be attributed the increasing success of this work of growing national importance.

A large number of British Standard Specifications and Reports have already been issued and these are constantly being added to, the most recent additions being the specifications for aircraft material and parts drawn up at the request of the Department of Aircraft Production of the Ministry of Munitions, for whom the Association acts practically as the Departmental Specifications Committee.

The standardization of steel sectional material was the first work taken up by the Committee. The British standards for this material, so important in the construction of ships, bridges and underframes for railway wagons, have had a very wide adoption. The total number of sections is some 175, and the recently formed Mercantile Section of the Admiralty, as a war measure, was able to select from this list a largely reduced number and so put into operation an exceedingly economical measure with but little delay. The testing requirements of Lloyd's Register and the other great classification societies and the Board of Trade have been unified through the work of the Committee.

It would appear from the steelmakers' returns for 1913 giving the tonnage of lengths rolled of each section that 95.7 per cent had been produced by standard rolls and only 4.3 per cent by non-standard rolls, the work thus having proved of immense utility to the steelmakers.

In the case of tramway rails, standardization has had the result of reducing to a minimum the sections required; at the present time there are only five standard sections as against over 70 sections prior to the advent of the committee. These sections are now being reduced to three, one being a special section for inter-urban tramways operating at a higher speed than those of the towns.

As a further instance of the benefit of the Committee's labors may be mentioned the standard specification for Portland cement, which is practically universally adopted throughout the country.

In regard to the electrical industry, the most important piece of work has been the issue of standardization rules for electrical machinery, in the drafting of which much benefit has accrued through the close and very cordial coöperation of the Standards Committee of the American Institute of Electrical Engineers.

A large amount of standardization has been effected also for the automobile industry, especially in regard to the special steels used.

From time to time Government Departments have called upon the Standards Committee to carry out work for them, as, for instance, in the case of the Ministry of Munitions in relation to the question of screw-thread tolerances and the gauging of screws generally. Then the Indian Government requested the Committee to undertake the question of standard designs for loco-

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motives, and these have proved of immense value. The Road Board also asked the Committee to draft specifications for road material. As already mentioned, at the request of the Department of Aircraft Production, the Association is dealing with the specifications for aircraft materials and parts as a war measure for the Department. To carry on this important work a large number of sub-committees have been formed, consisting of officers from the technical, supply and inspection departments, together with representatives from the various trade organizations concerned; the specifications in this case are not published by the Association in the ordinary way, but are issued to the Department of Aircraft Production, by whom they are sent to the various manufacturers of aircraft material on the Government list, in this way becoming obligatory.

In regard to the question of finance, the funds for carrying out the work of the Committee have been provided by the Government and the industries concerned. In 1903 the Government included in the estimates a substantial contribution, which was subsequently extended for the years 1904-5-6 by a grant-in-aid equal to the amount contributed by the supporting institutions, manufacturers and others. This was continued on a smaller scale down to 1916, and a further grant on the same condition is being continued to March, 1919. The Indian Government has been a generous supporter of the Committee and the Governments of other Overseas Dominions have also given financial assistance. A liberal response to the Committee's appeal for funds has been made by the engineering industry of the country and also by railway, shipping and other companies, and by some of the Local Government Boards and the tramway and electricity authorities.

The expenses of the whole organization up to the war were under £4000 a year, but, owing to the widening of the field of its labors, this amount has been very greatly exceeded.

The Committee, as many are aware, has recently become incorporated as an Association, under license of the Board of Trade, in order to enable it in the first place to continue the work carried out by the Engineering Standards Committee, viz. to coördinate the efforts of producers and users for the improvement and standardization of engineering materials, and, secondly, in order to secure undisputed legal right to its mark or brand to be attached by manufacturers to their products as a hall-mark of goods made in accordance with the British Standard Specifications.

The chairman of the Association is Sir Archibald Denny, Bart., who succeeded the late Sir John Wolfe Barry, to whose guiding hand during the many years of his chairmanship, so much of the success of the movement is due.

The Main Committee, as the governing Committee is called, consists of members nominated by the leading technical institutions, viz., the Institution of Civil Engineers, Mechanical Engineers, the Iron and Steel Institute, the Naval Architects, and the Institution of Electrical Engineers; there are also two representatives of the Federation of British Industries; and three members, not representative of any institution or association, but elected for their eminence in the profession.

The members of the Federation of British Industries give the various trade organizations connected with the work of standardization a direct channel through which to place their views before the Main or executive Committee of the Association.

Rotation of office is provided in that the chairman and vice-chairman and one-third of the group of members retire annually being eligible for reelection.

The Main Committee is the sole executive authority and all specifications and reports are presented to it for final adoption. The procedure before embarking on any new subject is to ascertain by means of a representative conference that there is a volume of opinion favorable to the work being undertaken. If such is the case, the Main Committee nominates the chairman of a sectional committee to take up the work in question, this committee being formed of technical officers representative of the various Government Departments interested, representatives of the trade organizations concerned, and lastly experts in the subject to be dealt with. The Main Committee does not dictate in any way either the number of members or the personnel of the sectional committee, only reserving to itself the right to nominate the chairman, though naturally it is guided in this matter also by the advice of the members.

Although the activities of the Association have in the main been confined to the home country, a considerable amount of work of an international character has been undertaken. At the present time the Association is coöperating with the American Institute of Electrical Engineers in several directions in regard to electrical apparatus generally. Then there is the great question of the standardization of screw threads and also of milling cutters and small tools, in connection with which The American Society of Mechanical Engineers will be able to render most valuable assistance. Indeed, there is a wide field for Anglo-American agreement on engineering standardization generally and the Association looks forward to a large measure of intimate coöperation with this object in view.

In connection also with its labors outside the home country, the Association is developing a scheme for assisting in procuring the wider dissemination of British Standards, and is undertaking the translation of its more important reports into various foreign languages, as well as setting up, with the assistance of the Overseas Department of the Board of Trade, Local Committees of British Engineers and Traders in some of the more important trading centres of the world.

That the value and utility of the work of the Association is becoming more and more recognized both at home and abroad is evidenced by the amount of new work it is continually being invited to undertake as well as by the inquiries received from all parts of the world both with reference to the standards and to the organization itself.

The most recent addition to the Association's activities is that of the standardization of the details in the construction of ships and their machinery. A conference recently convened at the instance of the Board of Trade, and representing Government Departments, shipowners, shipbuilders and engineers, classification societies and consulting and naval architects, has unanimously decided to recommend to the Main Committee the setting up of a complete section to deal with this branch of engineering, in which, in common with all others, economic production, fostered by interchangeability of detailed parts, is of such vital importance.

This brief account will, it is hoped, be sufficient to show that throughout the Empire, British Standards are receiving increased recognition as being of direct utility to the engineering industry generally. Standardization, after all, is no more and no less than proper coördination. To effect it may necessitate the sinking of much personal opinion, but, if its goal, through wideness of outlook and unity of thought and action, is the benefit of the community as a whole, standardization as a coördinated endeavor is bound increasingly to benefit humanity at large.

Technical Paper 178 of the U. S. Bureau of Mines, by S. M. Darling, which has been recently issued, deals with the characteristics and utilization of lignite. There are considerable lignite deposits in the Dakotas and Minnesota, yet the greater part of the fuel used in these states is imported from distant coal fields, involving long hauls. Mr. Darling's notes are intended to point out some of the ways in which that fuel may be used economically. It cannot be used in its raw form, except in the immediate neighborhood of the mine, because it contains 30 per cent of moisture. Instead, it must be modified so as to produce several products, each adapted to a particular commercial need, such as: Dried lignite for use with stokers or in gas producers; powdered fuel for use in furnaces, kilns and locomotives; dried briquets for large hand-fired industrial furnaces; carbonized lignite for use in suction producers; carbonized lignite briquets for use in domestic stoves and furnaces; and sulphate of ammonia and producer gas as obtained by the Mond process.

This publication gives much information as to the by-products obtainable from lignite and will be of value to those studying the problem of utilizing lignite as fuel.

THE WORK OF THE BRITISH ENGINEERING STANDARDS ASSOCIATION ON SCREW THREADS AND LIMIT GAGES

By SIR RICHARD GLAZEBROOK,[1] C.B., F.R.S., TEDDINGTON, ENGLAND

THE following notes give a résumé of the work done by the British Engineering Standards Association in connection with screw threads and limit gaging.

The importance of problems dealing with limits and gages was recognized at an early date by the Main Standards Committee, which appointed a Committee on Screw Threads and Limit Gages in February 1903. Two years later, after 23 meetings at which careful inquiries were made, and the merits of various threads, in particular of the Sellers Thread, were studied, the Committee finally decided that:

Having regard to the evidence laid before the Committee, and to the fact that the Whitworth thread is in general use throughout the country, the Committee do not recommend any departure from this form of thread.

It appeared, however, that there was a very general demand for a series of screws having finer pitches than those of the Whitworth form, and this led to the introduction of the British Standard Fine, B.S.F., series of pitches.

The Report contains tables giving the standard dimensions of these two series of screw threads, B.S.W. and B.S.F., and also of the British Association Series. It contains besides the following definitions:

Tolerance. A difference in dimensions prescribed in order to tolerate unavoidable imperfections of workmanship.

Allowance. A difference in dimensions, prescribed in order to allow of various qualities of fit.

Clearance. A difference in dimensions, or in the shape of the surface, prescribed in order that two surfaces, or parts of surfaces, may be clear of one another.

Effective Diameter of a Screw. The effective diameter of a screw having a single thread is the length of a line drawn through the axis and at right angles to it, measured between the points where the line cuts the slopes of the thread.

Core Diameter. The core diameter is twice the minimum radius of a screw, measured at right angles to the axis.

Full Diameter. The full diameter is twice the maximum radius of a screw, measured at right angles to the axis.

Crest. The crest is the prominent part of the thread, whether of the male screw or of the female screw.

Root. The root is the bottom of the groove of the thread, whether of the male screw or of the female screw.

Slope of Thread. The slope of thread is the straight part of the thread which connects the crests and roots.

Angle of Thread. The angle of thread is the angle between the slopes, measured in the axial plane.

Pitch. The pitch is the distance in inches measured along a line parallel to the axis of the screw between the point where it cuts any thread of the screw and the point at which it next meets the corresponding part of the same thread. *The reciprocal of the pitch* measures the number of turns per inch or millimetre as the case may be.

Initial Report on Screw-Thread Tolerances

The Committee next turned its attention to limits for plain cylindrical work and to limit gages for screw threads. The preparation of reports on these subjects involved a long series of experiments and measurements, many of which were carried out at the National Physical Laboratory.

The object of specifying tolerances was to secure interchangeability, and a little consideration showed the Committee that the element whose error most seriously affects interchangeability is the pitch; attention was drawn to the fact that the consequences of an error in pitch manifest themselves not only in the direction of the axis, but also at right angles to it, and it was shown that with an angular thread of angle α, a bolt and a nut of t inches in thickness, having a relative difference of pitch of p mils per inch, must have a difference of effective diameter of $pt \cot \alpha/2$ mils, in order that they may go together; pt clearly measures the total pitch difference of the screw and nut in the length engaged, so that the importance of the pitch error per length of engagement was appreciated from the commencement of the work. In the case of the Whitworth thread, $\alpha = 55$ deg., and $\cot \alpha/2$ is approximately 2, so that the rule was formed that for a screw of faulty pitch to pair with a perfect nut, the effective diameter must be reduced by twice the pitch error per length of engagement.

In the words of the report, the Committee had before them two separate matters to decide:

a To lay down tolerances on full core and effective diameters to cover the wear of tools and unavoidable imperfections of measurement, and to prescribe minimum allowances in order that bolts and nuts may be assembled freely.

b To decide what errors in pitch could be permitted in ordinary practice, having regard to the allowances in effective diameter which they entail.

The report contains the answers to these questions. Formulæ are given for the various tolerances and allowances, and a table of values worked out for the two series of threads.

Table 1 gives the tolerances for bolts ¼ in., ½ in., 1 in., 2 in. and 3 in. in diameter for B.S.W. threads.

Further Investigations of Tolerances

No further investigations were undertaken until the comparatively recent reorganization of a Sectional Committee on Machine Parts, their Gaging and Nomenclature and a Sub-Committee on Screw Threads for all purposes and their gaging.

War conditions have increased enormously the demand for interchangeable screws, while the experience gained has enabled a clearer idea to be formed of the real essentials of interchangeability and of the difficulty of securing them. It has become increasingly clear that fit at crest and root is in most cases unimportant. Large tolerances can be given on these dimensions; some authorities think it desirable to prescribe actual clearances, i.e., to formulate such dimensions that the bolt and nut can never come into contact at these points. In any case, it is agreed that for the work, an adherence to the exact amount of rounding at crest and root specified in the Whitworth thread is not needed. The elements which do matter are the pitch and the effective diameter: i.e., the lead and pitch diameter, to use the American terms, and also, to a less degree, the angle. The conditions applicable to munitions, guns, shells, fuses, etc., are somewhat special, and for these stores the tolerances possible have to be fixed in each individual case, but there is a very large demand for bolts and nuts, studs, and the like, using in most cases the finer series of pitches, and experience soon showed that the tolerances fixed by the Committee were too small. These various factors led to a reconsideration of its decision, with the result that a new report on British Standard Fine Threads and their Tolerances, was issued in June last. Corresponding reports on the Standard Whitworth Series B.S.W. Threads, and the B.A. Threads are in course of preparation, and it is hoped will appear very shortly.

Form of Thread

The question of the form of the thread was considered with great care, and the Committee had the advantage of discussing the series of pitches and other points of importance with the American Commission on Standardization of Aircraft Parts. It was clear to all that without deciding on the merits of the case it was impossible under existing conditions to alter the B.S.F.

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series of pitches, and it also appeared that provided the pitches were the same the 5 deg. difference in angle between the English and American threads would not prevent a very considerable degree of interchangeability. This conclusion has been substantiated by measurements since made on both sides of the Atlantic.

As to the form of thread, the evidence collected showed that, provided no close limits are placed on the exact curvature at crest and root, the rounded Whitworth form had distinct advantages from the manufacturing standpoint. The alteration suggested was the flattening of the crests in accordance with the theoretical Sellers thread. Further experience and measurement show distinctly that in practice the crests of American threads are frequently rounded, while it is agreed on all sides that rounding at the roots is essential to strength. Rounding at the roots is produced naturally by the wear of a sharp-pointed tool, and it appears probable that the radius selected by Whitworth (Radius $= 0.137\ p$, where p is the pitch) represents the stable condition reached by a pointed tool after some slight use.

Much the same is true at the crest; the difficulty of making a die with sharp corners that will stand wear is well recognized.

The Committee, therefore, decided to adhere to the Whitworth form, but without insisting on the exact curvature at crest and root so far as the work is concerned. In the case of a gage, however, their conclusion is that the theoretical form must be followed and attention given to the curvatures.

Tolerances on Form of Thread

It remained then to consider the tolerances. The measurement at the National Physical Laboratory of bolts and nuts made in the ordinary course of the work, and especially of aircraft and other similar parts, during recent years had afforded valuable information of the accuracy attained by manufacturers, as well as of that needed for interchangeability.

In dealing with tolerances it is convenient, whenever possible, to base them on a formula connecting them with the other dimensions on which they depend. For screw threads these are the pitch of the screw and the diameter of the cylinder on which it is cut—for a screw of given form the depth of the thread and the curvatures at crest and root are all proportional to the pitch. For the B.S.W. or B.S.F. series of bolts and nuts the pitch is definitely related to the diameter, and it appeared best to treat the tolerances as depending on the pitch only.

Mr. Sears, Superintendent of the Metrology Department of the National Physical Laboratory, was able to show that tolerances proportional to $\sqrt{p}$, p being the pitch, agreed very closely with those found to work well in practice over a large series of pitches, certainly over the whole range covered by the B.S.F. and B.S.W. series, and indeed some way into the B.A. series. He showed further that the quantity $0.01\ \sqrt{p}$, p being measured in inches, was a convenient unit of tolerance, and that the tolerances suitable for the B.S.F. series were all given by some small multiple of this quantity. Accordingly, for ordinary work, the Committee has specified the tolerances given in Table 2, while for finer work a table of close fits, having half the above tolerances, has been adopted.

TABLE 1 BRITISH STANDARD WHITWORTH SCREW THREADS

TOLERANCES FOR BOLTS

Nominal Diameter of Screw	No. of Threads per in.	Pitch	Tolerance on Pitch per in. length of Thread	Full Diameter			Effective Diameter			Core Diameter		
				Max.	Tolerance	Min.	Max. for a Screw of Correct Pitch	Tolerance	Min.	Max.	Tolerance	Min.
In.		In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
¼ (0.25)	20	0.05000	0.0035	0.2500	0.0018	0.2482	0.2180	0.0018	0.2162	0.1860	0.0023	0.1837
½ (0.5)	12	0.08333	0.0030	0.5000	0.0025	0.4975	0.4466	0.0030	0.4436	0.3933	0.0032	0.3901
1	8	0.12500	0.0025	1.0000	0.0035	0.9965	0.9200	0.0050	0.9150	0.8399	0.0045	0.8354
2	4.5	0.22222	0.0021	2.0000	0.0050	1.9950	1.8577	0.0084	1.8493	1.7154	0.0064	1.7090
3	3.5	0.28571	0.0019	3.4000	0.0060	2.9940	2.8170	0.0114	2.8056	2.6341	0.0078	2.6263

These tolerances are all negative on the bolt, positive on the nut, so that theoretically a bolt, if within the tolerances, should always pair with the corresponding nut, even if in the table of dimensions the maximum dimensions of the bolt are the same as the minimum dimensions of the nut, the dividing line being the theoretical form. But it is not possible to secure this in all cases. The gages used to test the work have their own tolerances, and are also subject to wear. To overcome these difficulties, an allowance of 2 mils is specified everywhere between the largest bolt and the smallest nut.

It seems probable that in the case of the close fits this will need reconsideration; for many purposes it is more important to secure a tight fit than to have complete interchangeability among a large series of bolts and nuts, and, with the figures given in the table, when the maximum nut is paired with the minimum bolt, and the pitches and angles of the two happen to be identical, the fit will be a slack one.

Tolerances in Pitch and Angle

It will be noted that the tables do not specify tolerances in pitch and angle; it has been pointed out already that in the case of a bolt an error in pitch can be compensated by a reduction of effective diameter of approximately twice the total pitch error; an error in angle can be compensated in the same manner. It is a necessary condition then for a bolt that the total reduction in effective diameter required to compensate the errors of pitch and angle must never exceed the permissable tolerance on effective diameter; a similar condition holds for a nut.

A simple graphical method of calculating the effective diameter equivalents of the pitch and angle errors has been devised by Captain Bishop, while a simple mechanism for applying Captain Bishop's method has been developed at the National Physical Laboratory. Denoting by x the effective diameter error, y and z the effective diameter equivalents of the pitch and angle errors, Captain Bishop introduced the term "grade" to denote $x+y+z$, the sum of these three; it will be found to measure the difference in diameter between the standard nut and a bolt of standard form which would just pair with a nut of the same dimensions as the bolt in question; the play, meaning thereby the lateral shake between the given bolt and a standard nut, is measured

TABLE 2 TOLERANCES IN TERMS OF PITCH

	Full Diameter	Effective Diameter	Core Diameter
Bolt	$3 \times .01\sqrt{p}$	$2 \times .01\sqrt{p}$	$4 \times .01\sqrt{p}$
Nut	$4 \times .01\sqrt{p}$	$2 \times .01\sqrt{p}$	$3 \times .01\sqrt{p}$

by $x - (y + z)$. For some purposes it is found convenient to specify screws by their grade and play. The grade indicates in a general way the difference between the bolt and the standard; the play gives a measure of the slackness of fit.

It has been pointed out already that the pitch error with which we are concerned is not the error per pitch or per unit length, but the total error in the length of thread engaged; the error per pitch which is permissible then will depend on the number of threads engaged, and the manufacturer who desires to know whether a tool cutting threads with some definite errors per pitch will cut a screw up to the specification, requires also to know the length of thread engaged. The Committee are now engaged on a series of tables which will give the corrections in effective diameter required to compensate pitch and angle error.

Gages and Gaging

The importance and difficulty of the question of gages and gaging have been before the Committee almost since its inception, and the principles on which it depends have been often stated.

The gaging of plain cylindrical surfaces is a simple matter; to gage a ring a go and a not-go plug suffice; for a shaft we need either go and not-go rings, or go and not-go snap gages. But for a complicated form like that of a screw, the matter is far from simple; the screw is made up of many elements, and each needs separate consideration. A little investigation shows, however, that for exact work the go gage must gage all the elements simultaneously, while each element requires a separate not-go gage. Thus, for a screw there are seven elements: Full diameter, core diameter, effective diameter, pitch, angle of thread, radius at crest, radius at root.

In symmetrical threads like the Whitworth, the last two elements are the same. The go gage insures that the work nowhere oversteps the theoretical boundary; the not-go gages confine the tolerances on the various elements within the specified values. If interchangeability alone is to be gaged, and a more exact knowledge of the errors of the various elements is not required, the not-go gages can usually be reduced to the first three. The form at root and crest is immaterial, provided the full and core diameters are not too greatly reduced: The go gage insures that the standard boundary is nowhere overstepped. The go gage also insures that the reduction in effective diameter has been sufficient to compensate the errors, if any, in pitch and angle, while the not-go effective-diameter gage provides that the effective diameter is not less than is tolerated in the tables. Thus, a complete go gage and three not-go diameter gages are needed.

It is easy to provide gages for the full and core diameters: In the case of plugs a simple ring, or a suitable snap gage, suffices; for nuts a plain cylindrical plug gages the core diameter; the full diameter is tested by a screw gage having one or two turns, with a very thin thread arranged to bear on the full diameter only. The effective diameter of a nut can be gaged by a screw plug of one or two turns, cleared at the roots, and with the crests ground off so as to bear only on the slopes of the threads; while for the effective diameter of a plug a ring gage bearing only on the slopes is available. A design of effective-diameter gage which is satisfactory and not too complicated has not, however, been found as yet, and the Committee are still giving the matter careful consideration. One of the difficulties is that of inserting the gage: an incorrect thread on a piece of work may be burred or contracted at the end at which the gage enters; it rejects the gage and is apparently correct, whereas had the gage passed the obstruction it would easily also pass the whole of the rest of the screw, which should therefore fail. To overcome this, various forms of expanding gages are under trial at present. The fact that it is necessary for the go gage to be complete in all its elements adds greatly to the difficulty of making gages. It is sometimes suggested that in the case of a ring gage used for bolts it is sufficient to clear the gage at the roots of the thread, and check the full diameter of the work with an ordinary ring gage. In the case of the Whitworth thread with rounded crests this is inadmissible for two reasons: (1) There is no security that the work in the neighborhood of the crest does not overstep the theoretical shape, and in this case it would not enter a nut of correct dimensions, and (2) there is no means of determining the concentricity of the various parts of the thread.

In the case of a flat-topped thread, the first difficulty does not occur; provided the parts of the thread are concentric the two gages give the necessary boundary exactly, but the second difficulty still holds. Concentricity can only be tested by a gage of complete form, and the construction of such a ring gage with flat roots is more difficult than that of one with the roots rounded to the Whitworth curvature.

Methods of gaging such as have been described are practicable enough when dealing with a limited amount of work; they become tedious, and, so far as effective diameter is concerned, not very satisfactory when dealing with masses of stores as in munitions work or the ordinary commercial supply of nuts and bolts. For bolts a method of gaging by projecting the image of the work on to a screen carrying an accurate magnified drawing of the screw under test has proved rapid and effective, and apparatus for this is in use in many factories.

Another method consists in keeping a careful watch on the tools employed, being assured that so long as they remain correct within certain limits the work they turn out will come up to specification. Most valuable work in this direction is being done by the Panel on Taps Sub-Committee, which is investigating the methods of measuring taps, the conditions that connect the size of a tap and that of the hole it taps, the limits within which taps must lie in order to give specified results and the like, and in due time the result of the work will be available. The Panel will also deal with dies and chasers.

Tolerances on Gages

Another series of questions is raised by the consideration of the tolerances to be allowed on gages; as a rough rule we expect these to be from 1/5 to 1/10 of the tolerances on the work. Their sign, however, depends on the purpose for which the gage is required.

Six classes of gages are recognized:

Standard gages, for depositing with a recognized authority; reference gages, for use by manufacturers; inspection gages, used by inspectors to check the accuracy of the work and determine if it is within the limits laid down; shop gages, used in the workshop to control manufacture; check gages, for verifying the accuracy of other gages; and master gages, used only in the manufacture of, or for the purpose of verifying, check gages.

Testing and Measuring Gages

The demand for munitions gages has led during the past few years to an important development of the methods of testing and measuring gages.

Until recently gages of all kinds have been dealt with at the National Physical Laboratory at the rate of about 10,000 a week; at present over 2,000 screw gages are being tested weekly.

Machines have been devised at the Laboratory for the rapid performance of the measurements required. In the case of a plug gage the diameters and pitch are all measured in suitable machines, the form of the thread is examined in a projection apparatus and the concentricity is tested by the use of a complete ring gage.

For a ring gage the diameters are checked by suitable go and not-go gages, the pitch is measured and the form is verified by taking a cast and examining it in the projection apparatus.

Through the coöperation of the industrial power plants which have thus far put into force the standard recommendations of the United States Fuel Administration to promote efficiency in the use of fuel, a saving of 7,000,000 tons annually has been effected. That is to say, in the first six months from the announcement of the national program, 3,500,000 tons have been conserved, at the same time maintaining maximum production in the factories. The largest savings have been in Massachusetts, Pennsylvania, Connecticut, Illinois and New York.—*Power*, Nov. 12, 1918.

PRESENT PRACTICE IN THREAD-GAGE MAKING

By FRANK O. WELLS,[1] GREENFIELD, MASS.

THE manufacture of thread gages brings in all the difficulties of any thread product, multiplied according to the degree of accuracy required. The usual methods of making threads must therefore be refined and improved, and at the same time standardized for manufacturing purposes.

Correcting Lead Screw

Given the blank for a thread plug gage, centered and turned, the real trouble begins with chasing the thread. A lead screw should be as accurate as the product to be turned out by it. Errors in lead screws are of two kinds—errors in lead over a considerable length of the screw, and local errors from thread to thread. If, as is often the case, the lead screw was made for ordinary work instead of for precision work, its lead or pitch will

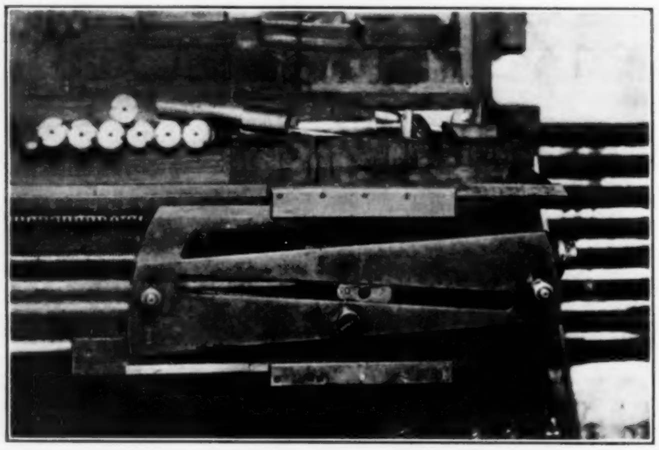

Fig. 1 Lead-Adjusting Attachment for Lathe

be irregular to a greater or less extent. The total deviation of the lead screw must then be determined, and the lead-adjusting attachment (Fig. 1), set to give the correct compensation.

The thread cut on a soft gage must always be slightly different from standard or finished pitch, by an amount equal to the expected change during hardening. This correction must also be made by the lead variator.

Adjusting attachments like that in Fig. 1 compensate fairly well for errors in the lead screw which are constant at any part of its length. They do not, however, take care of the trouble of "high and low" threads. In lathes used for thread-gage chasing the lead screw ought to be as perfect as possible from thread to thread and the ways of the lathe should be scraped accurately parallel and level so that the head and tail centers will be in line.

Chasing Tools

Given a fairly good lead screw, the next mechanical necessity is a good cutting tool correctly held. Such tools, with removable cutting blades, are shown in Figs. 2 and 3, one for inside and the other for outside chasing. It is a question whether a single cutting tool or a multiple-toothed chasing tool is better for this work.

The threading-tool blades in Figs. 2 and 3 are made to cut on a 20-deg. clearance angle. This clearance angle makes the actual included angle of the tool blade, normal to the straight cutting edge of the tool blade, 63 deg. and 8 min. The thread groove cut by a proper threading tool should preferably be from 15 to 30 min. sharp in order to facilitate the lapping operation. For all ordinary U. S. standard pitches the threading tool blade is set with its axis at right angles to the axis of the gage. It is only for Acme or similar very coarse thread work that it is necessary to incline the threading blade to a line parallel to the helix angle of the gage being threaded. When this helix angle is very steep it is necessary to modify the included angle of the cutting edge so that the angle cut, on a plane with the axis of the gage, will be as required by specifications.

A clearance channel is universally acknowledged desirable in a thread gage so that no chips lodging in the gage will bind between the gage and the thread crest of the tested thread and give a mistaken impression of a close fit.

There is great difficulty in getting men who are good at threading. Good threaders seem to be born, not made. The work requires a combination of brain, mechanical ability, sensitive touch, and above all, patience. Some otherwise good mechanics can never make good threaders. A green man with a phlegmatic temperament is a likely candidate for development. Few girls can be developed into handling fine threading—it requires just a little more mechanical sense than any appreciable number have had time to acquire.

With good men, fair lathes, the best cutting tools and the exercise of constant care, it is possible to get threading of gages

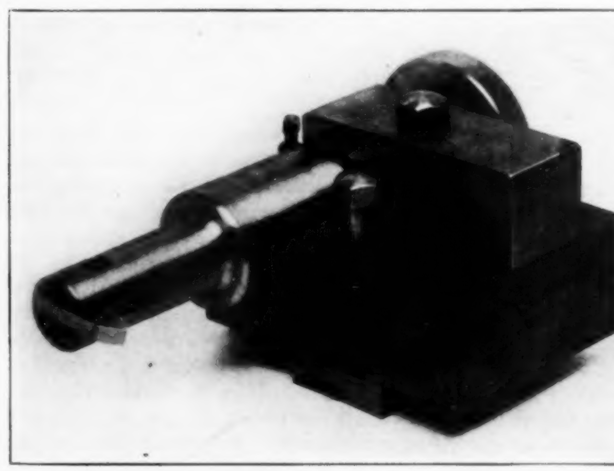

Fig. 2 Tool for Inside Chasing

down to a limit of accuracy which falls within the variations due to hardening. If a perfect contour of thread, and perfect angle, lead and walls could be secured when threading in a lathe, it would not be necessary to leave more than 0.0002 to 0.0006 in. oversize, knowing that hardening would increase this to from 0.0015 to 0.0020 in. Due to irregular swelling, shrinking and warping from thread to thread in the hardening, however, a certain amount of stock must be left on so that no point of the gage shall be distorted outside of the limits of the metal. If the thread, for instance, should take a quirk to the right so that its center line was displaced at the top of the crest by 0.0009 in., and the metal had been left 0.0015 in. larger than finished size, the reduction to finish could be made and still leave a complete crest.

Since a margin must be left for the vagaries of hardening, the necessary tolerance in lathe threading can probably be obtained by the precautions noted.

Formerly it was common practice to make the outside diameter of limit plug thread gages uniformly oversize in direct proportion to the oversize of pitch diameter. This practice was wrong because of the danger of the maximum or no-go plug forming contact on the outside diameter of the tapped hole and yet giving no indication as to the actual size of hole on the pitch diameter or the thread walls.

In view of the fact that both the go and no-go plugs are over

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For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application.

basic or maximum screw size, they should both be provided with a minus tolerance below the minimum tapped-hole outside diameter, in order to assure that the gage will positively check the angular diameter. This can be done since there is no danger of the screw forming contact with the outside diameter of the tapped hole.

Hardening

The hardening question has always been the bane of threading. A series of tests made sometime ago by laboratories of manufacturing firms throughout the country demonstrated that threading on taps and dies can be gotten down to any reasonable limit of accuracy, but that this is not true of hardening. The inaccuracies in taps and dies, manufactured as is necessary by quantity methods, in general appear after hardening and are not present in the soft product. The same is true of gage threads, only of course the error involved is proportionally of more importance on such fine work.

During the process of hardening there is in the majority of cases an increase or swelling in diameter and a shrinkage in length, resulting in a shortening of lead, but the extent to which this occurs will vary in different pieces. Even with the quenching bath and the temperature of furnace kept uniform, the swelling in diameter in one set of duplicate samples of about an inch in diameter varied from 0.0008 to 0.0024 in., and the lead error varied from 0.0005 to 0.0025 in.

The only way to control this is to find a heat treatment and a quenching bath which will always give the same expansion and contraction under standardized methods of working and dipping, then see that the handling methods actually are standardized. And not only must uniform handling methods be followed, but the steel must be of uniform quality. For this reason it is necessary to have a supply of steel from which any piece may be taken and relied upon to act like every other piece. If such steel cannot be secured from the steel men, it is advisable to get the most uniform brand available and then standardize it still more by heat treatment.

Lapping

If the lathe work has been done correctly and the hardening without distortion the thread can be smoothed to a finish by lapping off not much more than 0.0002 in. Under ideal conditions, therefore, this would be the amount of oversize that would be specified for gages coming into the lapping room. A much neater and quicker job of cleaning the thread to size could then be done, and the cost of lapping would go down.

However, not only excessive oversizes but distorted pieces come into the lapping room. The lapping process can to a certain extent take out these inequalities as well as smooth the surface of the chased thread. It should be emphasized, however, that the lapping process is not for this purpose and that every correction that has to be made in the lapping costs excessively and slows up the other work. Lapping should not be depended upon to do correcting, but the threading should be in correct shape before reaching the lapping room.

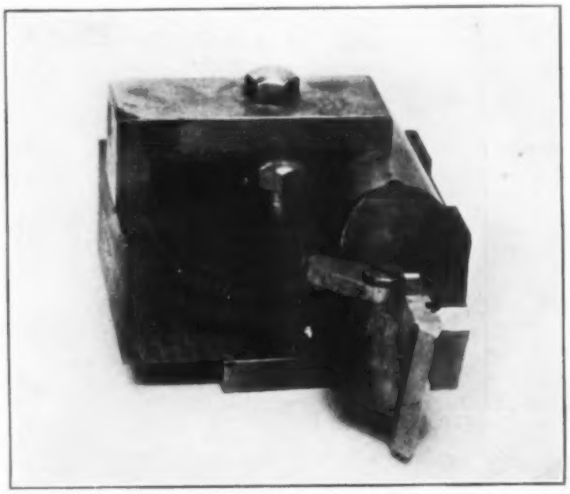

Fig. 3 Tool for Outside Chasing

If the angle of the thread is slightly too wide or narrow or tipped to one side, a skillful lapper can correct it. If the lead is a trifle too long or short, the lap can take it back to the proper length, by wearing the surface off on one side or the other of each thread. If the pitch diameter is too large, it can be worn down. But, of course, there is a limit to the amount that can be worn off by hand-applied friction, using the general form of thread as a guide, and still retain an accurate contour. It is practicable to take off a total of 0.0015 in. by lapping without spoiling the shape, if it is done carefully on only one gage. Therefore, allowing part of the overstock for smoothing, if the errors are not cumulative or all in the same direction, it is possible in lapping out 0.0015 in. oversize in diameter, to take care of an error of 0.0005 in. in lead and an error of 15 min. one way or the other in the angle.

Two forms of lapping machine for thread plug gages are

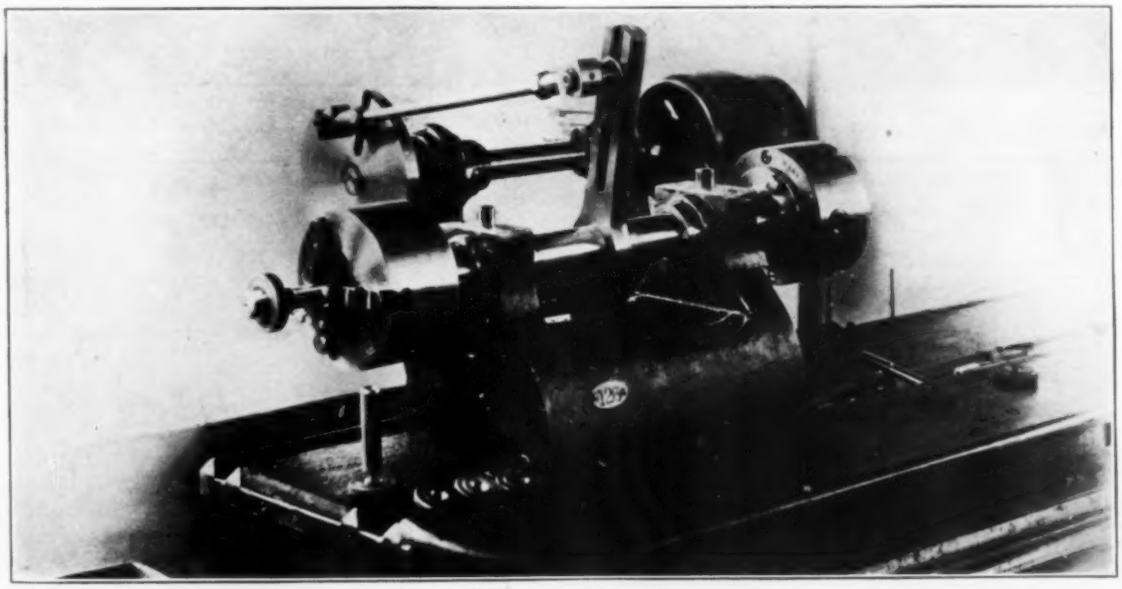

Fig. 4 Double Lapping Machine

shown. In the best plug-lapping machines the plug is mechanically rocked back and forth through a fraction of a revolution, while the operative holds the lap still in one hand, encircling the plug. threaded more accurately than the gage which it is to correct. Flour of emery makes the most satisfactory lapping medium for thread gages, particularly for lapping the thread walls. Fifteen-

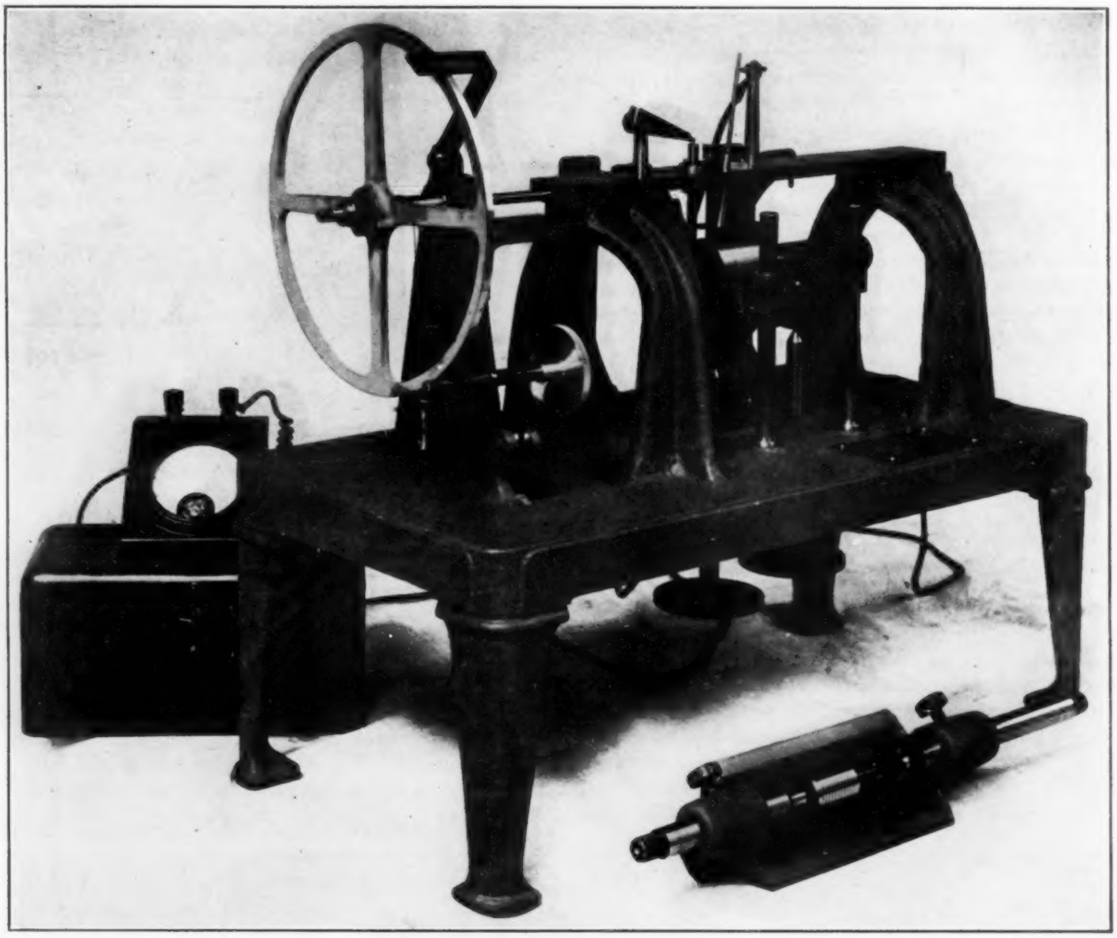

FIG. 5 BINGHAM-POWELL LEAD-TESTING MACHINE

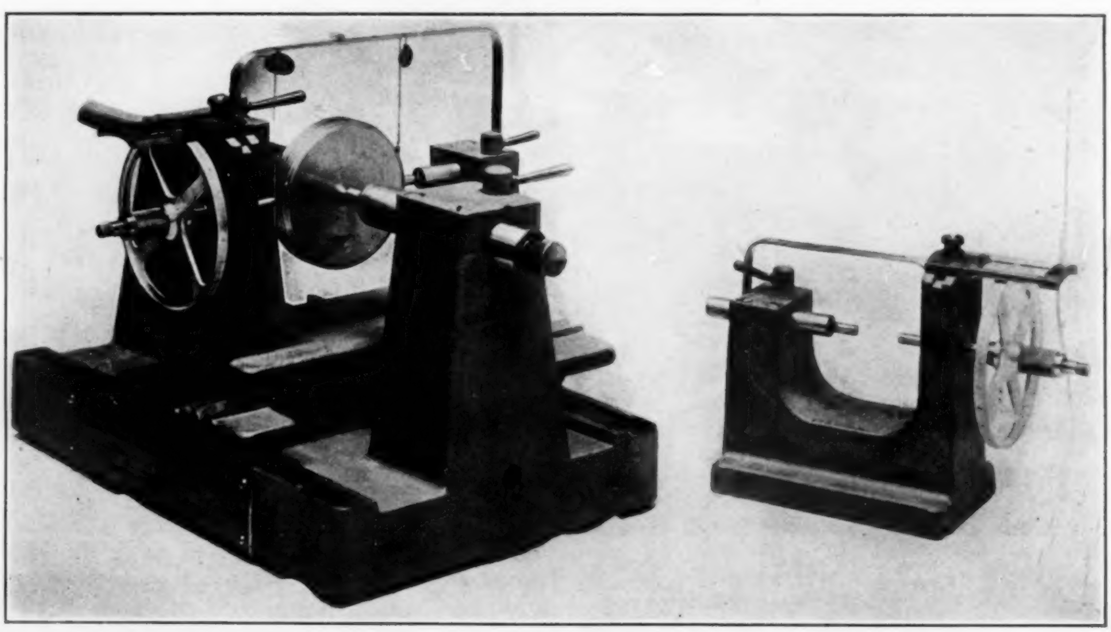

FIG. 6 MACHINE FOR TESTING PITCH

Since the operative might as well be using both hands, a double ended machine is provided, shown in Fig. 4.

Soft steel laps are most easily chased out smoothly and are the most durable. Some prefer cast-iron laps, however. The lap is an important part of the work; it must, of course, be minute carborundum is satisfactory for lapping outside diameters. Sperm oil makes the most satisfactory medium for carrying the abrasive, chiefly because of its non-gumming quality and because at the same time it has more body than kerosene, which is quite commonly used.

Grinding Threads

Grinding out the inaccuracies in the larger-size threads is much more expeditious and cheaper than lapping them out. The problem of grinding threads becomes difficult, costly and impracticable, however, below a certain minimum size, in general, for the following reasons:

In grinding out a V-thread as near as practicable down to the theoretical triangular point, as is done in thread gages, there is intensified friction upon the delicate edge of the wheel and it wears away very quickly. It could not be used at all, were it not for the fact that the extreme edge of the wheel does not have to be maintained absolutely as an acute angle. On all practicable manufactured screw threads upon which the gage is to be used, whether U. S. S., International or Whitworth, at least the top eighth of crest is flattened or rounded off. Therefore, although the profile of the gage thread must be kept accurately straight along seven-eighths of the wall, the remaining eighth in the extreme root can be allowed to become a little rounded off, since it will not engage any part of the thread but will be used as a clearance space.

Now an eighth of a large pitch on a large diameter gives the wheel edge considerable margin for wear. The absolute length of this margin decreases toward the point in proportion as the pitch from thread to thread decreases, and soon the point is reached where the allowable eighth margin at the edge of the wheel wears away too fast for practicable replacement of wheels. One wheel should do at least one complete gage before needing to be trued at all, since the wheel cannot be taken out and put back in the same place with any success. This margin of wear on the wheel is now generally reached at a pitch of 16 threads to the inch, so that most gages below 5/16 in. pitch diameter have at present to be lapped out instead of ground.

There are other difficulties in the way of grinding small threads. On the average, the best thread-grinding wheel is about No. 150.H, as we find in our own work. For the grinding process, from 0.003 in. to 0.008 in. of stock should be left on a thread gage to enable the operative to set his wheel in the center of the thread by adjustment and trial, and also permit him to correct inequalities in lead, angle, or diameter due to hardening.

Out of 0.003 in. of stock he can increase or decrease the lead by 0.001 in., if the angle is already correct. Similar corrections in the other dimensions may be effected.

Work coming from the grinding room is then lapped smooth before it goes to the inspection room.

Inspection

Inspection in gage manufacture assumes an importance that it has in hardly any other branch of work. This is still more true of thread gages. The many dimensions that are on an apparently simple product require close attention to each separately and to all together.

To test the lead the Bingham Powell machine is a good instrument. The method of holding the gage, the micrometer wheel and vernier and the electric telltale which indicates proper contact of the measuring fingers and the thread, are shown in Fig. 5.

A testing machine fitted up with a slide rest in parallel so that only two wires are necessary is good for measuring pitch diameter, by aid of a micrometer reading. This machine is provided with two removable tables, one for large work and one for small, as shown in Fig. 6. To test the micrometer a set of Johansson blocks should be on hand, and finally to resolve immediately any doubts one might have as to the accuracy of a particular block or measurement, a good measuring machine should be on hand.

To examine the contour of the thread, the angle and the root, crest, and smoothness of wall, a projection machine as shown in Fig. 7, is the only proper thing. It instantly gives an enlarged silhouette of the thread, which speaks for itself, for the profile can be compared with pattern gages held upon the screen as in the illustration. The silhouette can also be photographed for transmission to a customer, by inserting a film or plate instead of the ground glass. Mechanism is provided for holding the gage, for focusing it and for turning it to the helix angle so as to get a symmetrical projection of the walls.

Sulphur casts of female threads can be taken in quick time and at small cost, and the contour examined in the same quick way. The method of pouring the melted sulphur into a molding frame held against part of the thread so as to get enough of it to give contour and lead, is shown in the complete paper.

Tolerance on Gages

One great difficulty with the business of manufacturing thread gages is the unreasonable and useless accuracy of gage tolerance and wear allowance sometimes requested by purchasing firms. When a tolerance of 0.0002 in. is set on a gage specification, it should mean that the customer's tolerance on product is as close as 0.001 in. If the purchaser's manufacturing tolerance is any broader than that, there is no use in keeping the gage so close.

Fig. 7 Projection Machine for Checking Contour of Thread

A 0.0002 in. error would be lost in the comparison. In order to facilitate the making and to lessen the cost of thread gages, it is well to allow quite liberal tolerances in their manufacture, and we recommend the following as being applicable for most cases where medium tolerances are allowed on product:

From 4 to 6 pitch allow a tolerance of 0.0006 in.; from 7 to 18 pitch allow a tolerance of 0.0004 in.; from 20 to 28 pitch allow a tolerance of 0.0003 in.; from 30 to 80 pitch allow a tolerance of 0.0002 in.

The foregoing applies to master gages. For inspection gages the tolerances would be slightly wider, and would begin where the master inspection gage tolerances leave off. These would be as follows:

From 4 to 6 pitch a tolerance of 0.0009 in.; from 7 to 10 pitch a tolerance of 0.0006 in.; from 11 to 18 pitch a tolerance of 0.0004 in.; from 20 to 28 pitch a tolerance of 0.0003 in.; from 30 to 40 pitch a tolerance of 0.0003 in.; from 44 to 80 pitch, 0.0002 in.

All of the foregoing tolerances would be applied plus in the case of go male gages and no-go female gages; and minus on no-go male and go female thread gages.

The plus and minus tolerances given apply to pitch diameters of all thread gages and also to root or core dies of templets or female thread gages.

The maximum, or go, templet gage represents the maximum or basic screw and its manufacturing tolerances should be minus on pitch diameter and root diameter. The minimum, or no-go, templet should be made to plus tolerances with an extra plus allowance on the root diameter, which will insure this gage's really checking the effective size of the screw. The wear and adjustment tolerance on a gage should be coarse or fine on a sliding scale according to the manufacturer's tolerance on his product.

STANDARDS FOR LARGE TAPER SHANKS AND SOCKETS

By LUTHER D. BURLINGAME,[1] PROVIDENCE, R. I.

WAR needs have demanded the construction of machine tools embodying taper shanks and sockets of larger dimensions than it has been customary to build them. Most of the tapers established in the early days before the question of standardization was given much attention, present irregular variations in size and in depth, even within the same system, as will be noticed by observing the figures given in Table 1, where the most widely used tapers are described. The application to the large sizes of the rules followed in proportioning these early types, does not give the dimensions required to meet the new conditions.

The problem of working out a standard for the large sizes necessitated by present exigences was presented to the Brown & Sharpe Mfg. Co., and after an extended investigation and study of the conditions to be met, it has arrived at the tentative form described in this paper. The choice was based on a study and analysis of present established tapers, an investigation of the laws governing the use of tapers and a referendum of experience and opinion from a number of manufacturers and engineers who, because of their close contact with conditions most nearly like those desired to be met, it was felt would best be able to judge of the requirements.

TABLE 1 DATA ON TAPERS IN GENERAL USE

Taper per ft., in.	Included Angle	Ratio	Name	About when introduced	Where Used
½	2° 23′	1:24	Brown&Sharpe	1860	Milling machines and general
6/10	2° 52′	1:20	Jarno	1889	Reed lathes, Pratt & Whitney machines, etc.[1]
⅝	......	1:19⅞	Morse	1862	Twist drills, drill presses, etc.
¾	3° 35′	1:16	Sellers	1862	Lathes, boring machines, milling machines, etc.
1	4° 46′	1:12	Cambria	......	Steam-hammer piston-rod ends
1½	7° 9′	1: 8	Muir(England)	......	Milling machines, "patent couplings" for arbors

[1] Also since used for German metric tapers.

Taper per Foot

As shown in Table 1, the well-established tapers for shanks and sockets now in use vary from ½ in. to 1 in. or more per ft., the tendency being to use a somewhat steeper taper for the larger than for the small sizes, perhaps because with small tapers, the liability to slip produced by the work is not so great and the "bite" of the taper when forced into the socket is sufficient to secure effective driving. In the larger sizes, tenons or tongues must be provided to aid in driving, and in the still larger sizes keys of some form are needed, as, unless the angle of taper is very slight, the tenons are liable to be twisted off. When such auxiliary means of driving is provided the taper can be made steeper, giving the advantage that the parts can be more easily separated.

An illustration of the use of a greater taper per foot for large as compared with small sizes is found in the "old American taper" having $\frac{6}{10}$ in. taper per ft. up to the size 1 in. in diameter at the small end, beyond which the taper became ⅝ in. per ft.

An extreme application in the direction of steep tapers is in the arbor couplings used for milling-machine arbors, made by Wm. Muir & Co., Ltd., of England. These arbors are drawn into and removed from the socket by means of differential-threaded nuts, the taper being 1½ in. per ft.

On the other hand, tapers as slight as ½ in. per ft. have given satisfactory results in milling machines and other machine tools, where they have been in constant use for at least the last sixty years. The "bite" on the small sizes is sufficient, when driven in place, to hold without working loose under jar, while the angle is not so small as to prevent driving apart when desired. It is found, however, that occasionally a taper of ½ in. per ft. will stick so tightly as to require considerable force to separate the parts, perhaps in such cases as where a cold arbor is driven into a heated spindle. With a taper as slight as ½ in. per ft. there is seldom trouble from having the tenon twist off, as is so often the case with twist drills made with a taper of approximately ⅝ in. per ft., and where on account of the greater taper the "bite" of the taper fit does not carry so great a proportion of the load.

TABLE 2 MAGNUM STANDARD TAPERS, DESIGNED BY THE BROWN & SHARPE MFG. CO.

No. of taper	Diam. at large end, in.	Diam. at small end, in.	Depth of taper, in.	
19	4	3¼	12	Taper = ¾ in. per ft. Depth of taper = 2 × diameter at large end + 4 in.
20	5	4⅛	14	
21	6	5	16	
22	7	5⅞	18	
23	8	6¾	20	
24	10	8½	24	
25	12	10¼	28	
26	14	12	32	

TABLE 3 EXPERIENCE OF MANUFACTURERS WITH LARGE TAPERS

Name	Kind of machines	Taper per foot recommended	Depth recommended	Remarks
William Sellers & Co., Inc. Coleman Sellers, Jr.	Lathes; horizontal boring machines	¾ in.	At large end, 3 × diam. (or a little less)	Have used up to 8 in. diam.
Mesta Mach. Co. J. E. Mesta, Asst. Supt.	Rolling-mill machinery, etc.	½ in.	3 × diam.	....
Newton Mach. Tool Works Nicholas P. Lloyd, Gen. Mgr.	Milling machines, etc.	Use ⅝ as std.; rec. 1 in. for large	....	Have used to 6 in. diam.
Tabor Mfg. Co. Wilfred Lewis, Pres.	General	0.6 or ¾ in.	....	....
Mead-Morrison Mfg. Co. J. T. MacMurray and Robt. Gow	General	1 in.	About 1½ in. × diam. + 2 in.	....
Westinghouse Elec. & Mfg. Co. E. R. Norris	General	¾ in.	3 × diam.	....
Bement & Miles W. J. Hagman	Steam hammers	½ and ¾ in.	....	The greater taper used for sizes above 3½ in.
	Steam forge hammers	1 in.	....	Sizes 2¼ to 12 in. diam.
	Lathes	¾ and 1 in.	Up to 5 in. at large end, 2½–3 × diam. 5 in. & over, 2.1 & 2½ × diam.	Sizes above 5 in. are 1 in taper per ft.
	Drilling & boring machines	⅝ in.	....	All sizes
	Milling machines	¾ in.	....	All sizes

[1] Industrial Superintendent, Brown & Sharpe Mfg. Co., Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

Principles on Which Tapers Depend

Oscar J. Beale of the Brown & Sharpe Mfg. Co., originator of the "Jarno" taper, made an investigation of the principles on which the taper of shanks and sockets should be proportioned, and published his findings in the *American Machinist* of October 31, 1889, p. 3. His analysis is a clear statement of conditions governing the taper per foot.

After asking, "Is there a scientific principle involved in establishing a taper?" he answers: "There is this principle, that the angle of the taper must not be so large that a center will not stay when driven in and that the angle need not be so small as to make it very difficult to back the center out," and after illustrating by means of a diagram he continues: "The average angle of repose in metals having smooth surfaces that are oiled is placed by Unwin at 4½ deg. and by Willis at 5 deg. Rankine gives an angle the same as or a little smaller than Unwin and adds that in some experiments the angle has been as small as 2 deg." From a further demonstration Mr. Beale concludes, regarding tapers, that if the angle must be such as to permit slipping, it should be as great as 10 deg., while if it should not permit slipping, it should be less than 4 deg. Also:

> If a center be of a taper whose sides make an angle of less than 4 deg., it is not likely to slip out, after being driven in, even though it be oiled. An angle of 4 deg. makes a taper of nearly ⅞ in. per ft. No center, so far as I have seen, has a taper greater than this, which is interesting as indicating that the machinist, in practice, has not exceeded the angle of safety given in the textbooks. . . . The smallest center angle that I know is something less than 2½ deg., which in practice has been found to be small enough. We are therefore at liberty to choose any angle of taper between 2 and 4 deg.

Mr. Beale chose for the Jarno taper, 0.6 in. taper per ft. (2 deg. 52 min.) as an average between these limits. This gives a ratio of 1 in 20, a ratio which has since been adopted for the German metric standard and is especially adapted for use with a decimal system of measurement. In applying it to the English system of measurement, however, it gives the dimension at one end of the taper in tenths and at the other end in eighths, a feature which, while not especially objectionable, lacks the advantage derived from using the taper of ¾ in. per ft., which gives, with each inch of depth, $\frac{1}{16}$ in. variation in diameter, so that when applied to large tapers, whose depth may be made to vary by 2 in. or 4 in., the diameter at both large and small ends come in whole or convenient fractional sizes.

A taper of ¾ in. per ft. also gives an advantage over 0.6-in. or other tapers with a less steep taper in the ease with which it will release when it is desired to drive it out. Further, it is a taper which apparently is now in most general use for large work, although its proportions, as far as the writer knows, have not previously been standardized.

The taper of ¾ in. per ft. was adopted by William Sellers & Co., Inc., of Philadelphia, about 1862, when they abandoned the flattened end or tenon and adopted a key fitting lengthwise of the taper for driving, rather than to depend largely upon the "bite" of the taper for that purpose.

William H. Thorne, in a paper[1] on Twist Drills presented before The American Society of Mechanical Engineers in 1885, after pointing out the objections to driving by a tongue as is the usual practice in using twist drills, says:

> A far better device is a key, fitted permanently into the sockets, and extended the entire depth of the latter. This key fits a groove in the shank of the drill, and supplies a perfect means of driving the latter, with a minimum of wear and strain. The end of the shank for a short distance is turned smaller, and is hardened to prevent any upsetting by the use of a drift or wedge in removing the drill. The amount of taper proper for the shank is a disputed question. The Morse taper averages less than ⅝ in. in diameter per ft., but with drills driven by means of a key ¾ in. per ft. is better as it enables the drills to be more readily removed from the sockets, and at the same time prevents them from falling out by their own weight.

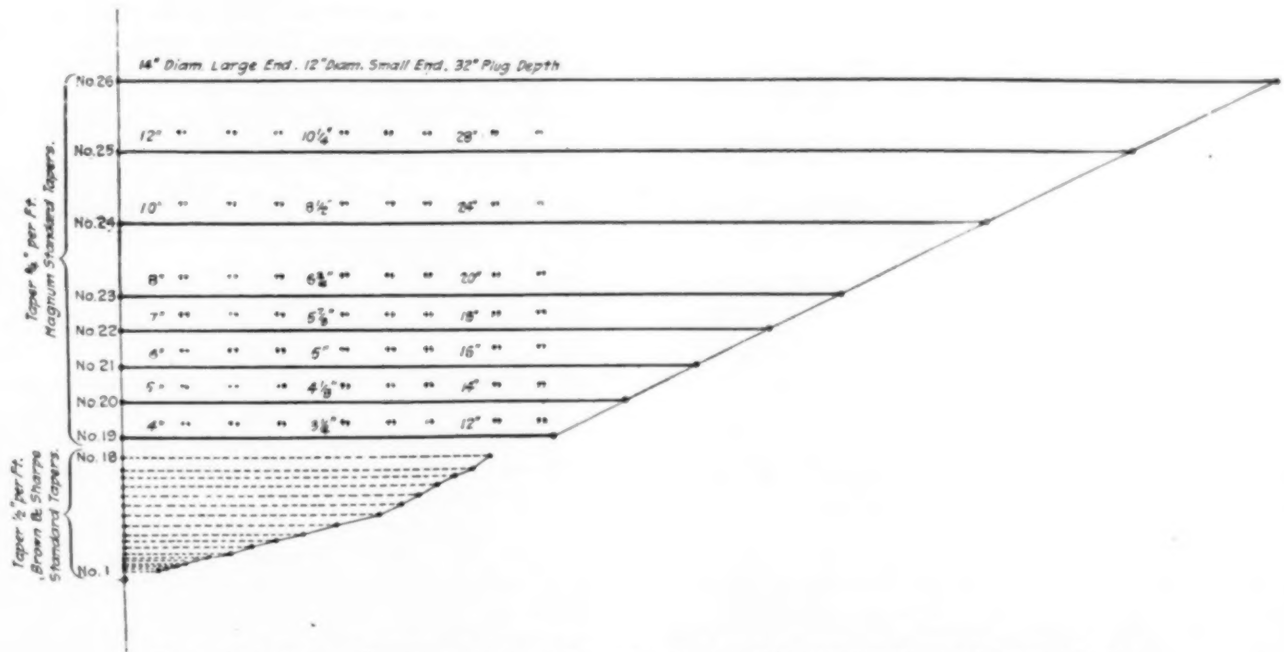

Fig. 1 Relation of Proposed Standard Taper Lengths to Established Brown & Sharpe Sizes

Mr. George R. Stetson, in discussing Mr. Thorne's paper, said:

> The objection to a sharper angle or taper is that the drill has a tendency to draw out of the socket when coming through its work. This twists the tongue and produces most of the trouble complained of and would be best obviated by a taper of less than ⅝ in. to the foot.

What applies to the use of tapers for drills in this discussion applies in general to the use of tapers for sockets and shanks, and the conclusion can be drawn that if the "bite" of the shank is to be depended on to a considerable extent to do the driving, the taper should be small, even at the risk of finding occasional difficulty in separating the parts.

On the other hand, if adequate means of driving is to be provided in addition to the "bite" of the taper, there are advantages in making the taper greater, although not so great as to allow of jarring loose or dropping out readily.

Assuming that in all cases of machine tools using these large tapers either longitudinal or cross-hold-back keys or both will be

[1] Trans., Vol. 7, p. 132.

used for driving them, a greater taper per foot can be used, thus obtaining the advantage of easy removal with no sacrifice in driving efficiency. To meet these conditions, a taper of ¾ in. per ft. for large sizes seems ideal, based on scientific grounds and also on the experience of users.

Lengths for Tapers

While the length can be more elastic, a variation being less objectionable than in the case of the diameter or taper per foot, it is desirable to standardize it also. As previously pointed out, the tapers already established do not give proportions for lengths suited to large sizes. Thus the Jarno formula would make a taper of 14 in. in diameter at the large end, 56 in. long—much too long for practical needs and adding an excessive amount to the cost of both gages and reamers as well as of the machine. A proportion used by some Philadelphia manufacturers who have made the depth three times the diameter for moderately large sizes, is admitted by them to be probably longer than necessary even for these sizes. Such a proportion would make the above 14-in. taper 42 in. long.

The Proposed Standard

By the use of a constant, a formula has been derived applicable over a wide range, and giving, it is believed, satisfactory proportions. Fig. 1 illustrates the relation of the proposed taper standard for length as derived from this formula, to the established Brown & Sharpe sizes, showing that these new tapers follow in a regular progression beyond the largest established Brown & Sharpe sizes.

As a result of this investigation the sizes in Table 2 are proposed, to be known as Magnum Standard Tapers.

The reason for beginning the numbering at 19 is to avoid lapping on to the numbers of any of the systems now in use, No. 18 of the B. & S. standard being, so far as known, the largest standard as yet suggested. No. 19 of the new system is proportionately larger than the B. & S. No. 18, so that, starting with No. 19 seems logical, even though the new standard has a different name and is of a different taper per foot than the old.

It will be noted that the diameters at the large end are made basic and vary by inches, and with the length of taper obtained by the formula the diameters at the small end are in convenient fractional sizes.

Before determining on the proportions of the Magnum tapers the question of the proportions of large standard tapers was taken up with manufacturers and engineers having experience along these lines. Table 3 gives a digest of the opinions received from various sources in answer to the writer's inquiry as to their past experience with large tapers.

DETERMINATION OF STRESSES IN WIRE ROPE AS APPLIED TO MODERN ENGINEERING PROBLEMS

By JAMES F. HOWE,[1] WORCESTER, MASS.

The consideration of stresses in wire rope necessitates the consideration of this problem from a broad standpoint so that each factor governing the action of wire rope will be fully understood. The structure of wire rope is such that axial compressive stresses need not be considered, only those allied to tension or bending requiring study. The first problem to be considered and the one upon which all stresses depend, is the determination of the strength of strands and ropes.

Strengths of Strands and Ropes

In constructing a wire rope a number of wires arranged according to some definite geometrical cross-section are twisted with a uniform pitch or lay into what is technically known as a strand. The object of twisting the wires into strands and strands into rope is to bind the wires compactly together and to increase the flexibility of the wire rope. Both the wires composing the strands and the strands composing the rope are twisted and laid up so that there is no torsion in either the wires or strands.

While stranding increases flexibility, it is not accomplished without some loss in strength due to twisting. It is obvious for comparative purposes that the strength of a straight wire may be taken as unity or 100 per cent. Strands are usually made of 7, 19, 37, 61, etc., wires, and ropes of six strands (occasionally eight). When a number of wires are twisted together around a central wire, they make an angle with the central wire or axis. The shorter the twist the greater the flexibility, but at the same time the strength is decreased proportionately. This will be understood from Fig. 1.

A wire with a strength S in a strand will have a component strength T along the axis of the strand, or

$$T = S \cos \theta$$

where

θ = angle of helix of wire in the strand.

Also, if

D_p = pitch diameter of strand

n = lay divided by pitch diameter of wires

d = diameter of wire in strand (assuming all wires the same size)

c = constant by which wire diameter is multiplied to produce pitch diameter

$$\text{Pitch circumference} = \pi cd \text{ and Lay} = nD_p \quad [1]$$

In the case of a seven-wire strand, the center wire being straight, the total strength of strand W_s is obviously

$$W_s = S + 6S \cos \theta = S(1 + 6 \cos \theta) \quad [2]$$

If θ_1, θ_2, θ_3, etc., represent the angle of the helix of successive layers of wires in a symmetrical concentric strand for layers of 12, 18, 24, etc., wires,

$$W_s = S + 6 \cos \theta + 12\, S \cos \theta_1 + 18\, S \cos \theta_2 + 24\, S \cos \theta_3 + \text{etc.},$$
$$= S(1 + 6 \cos \theta + 12 \cos \theta_1 + 18 \cos \theta_2 + 24 \cos \theta_3 + \text{etc.}) \quad [3]$$

If the angles θ, θ_1, θ_2, etc., are equal the equation becomes

$$W = s\,[1 + (N - 1) \cos \theta] \quad [4]$$

where N = number of wires in strand.

Similarly in a rope,

let W_r = strength of rope with hemp center

Y = angle of strands in rope (assuming 1 layer of strands such as 6 or 8)

N_1 = number of strands in rope.

The strand strength W_s must be applied in just the same manner as before, and

$$W_r = W_s N_1 \cos Y \quad [5]$$
$$= SN_1 \cos Y\,[1 + (N - 1) \cos \theta] \quad [6]$$

if all wires are twisted with equal angles.

In the case of solid strands such as 7, 19, 37, 61, etc., wires the results obtained from Formulæ [2], [3] and [4] are very close to actual figures. In the case of ropes, however, some other factors must also be considered.

In testing a full-size specimen of a wire rope there is always some nicking action between the strands as the load approaches a maximum, due to the compression of the hemp center. The larger the rope being tested or the stronger the rope of any diameter, the greater the compression of the hemp center will be. In fact, it has been found necessary in many cases where ropes are employed for very heavy duty such as in dredging operations on large sizes to manufacture wire rope with a wire

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For presentation at the Annual Meeting, New York, December 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper, which contains many useful tables on rope stresses, may be obtained by members gratis upon application. All papers are subject to revision.

center consisting of a smaller wire rope contained inside of the larger one. Still another factor which will affect the general results is the kind of material of which the rope may be composed. Very high-strength material in rope construction reduces somewhat the efficiency of a wire rope when tested to rupture. By efficiency is meant the ratio between the break of the completed rope and the sum of the strengths of the separate individual wires.

No single value for efficiency of break can be assigned to any given construction such as 6 x 19 as this varies somewhat for the different grades of wire used in rope making and also the angle of lay of strands, etc., which may be changed from time to time to suit service conditions. This fact was recognized by the rope manufacturers of the country at their 1910 conference in the establishment of standard breaking strengths.

In making up specifications for wire rope for any purpose, the data on strength published by the various rope makers may be considered as fairly reliable. These values of breaking strengths are intended to represent approximately average values. They may vary two or three per cent under or they may run over. This variation, however, will make very little difference with the factor of safety used in the engineering calculations.

The stresses to which wire ropes are subject in service may be grouped in two main divisions, namely,

1 Direct stresses due to applied load	Static tension	*a* Vertical lift *b* Inclined lift
	Moving tension	*a* Acceleration of load *b* Retardation of load
2 Indirect or induced stresses	Bending	*a* Direct bending *b* Reverse bending
	Horizontally suspended cable supporting load.	

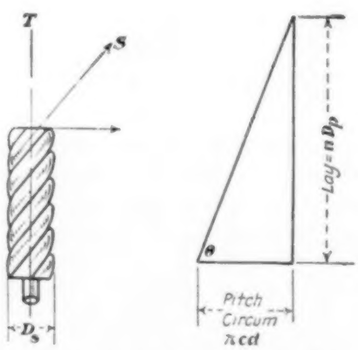

FIG. 1 EFFECT OF TWISTING WIRE ON THE STRENGTH OF ROPE

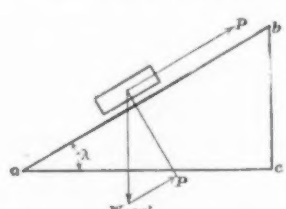

FIG. 2 DIAGRAM OF FORCES IN PULL ALONG INCLINED PLANE

STATIC TENSION

Considering these stresses separately, it is a simple matter to calculate the load to be lifted and add to this the weight of rope suspended vertically, thus obtaining the direct static tension.

Let W = load to be lifted
w = weight of rope per foot
l = length of rope suspended vertically
L = total load or tension.

Then

$$L = W + wl$$

INCLINES

For an inclined lift Formula [1] will be modified somewhat as follows (see Fig. 2):

Let λ = angle of incline
P = pull due to load $W + wl$
F = friction factor, which is a function of $(W + wl)$ and the angle of the incline λ
$P = (W + wl)\ F \sin \lambda$.

The friction F of the cars on the incline operates normal to the line *ab* and is therefore a function of $\cos \lambda$. The maximum value is when $\cos \lambda = 1$, or on a level track, and the minimum for $\cos \lambda = 0$ when $\lambda = 90$ deg. Starting friction being the greatest, this alone need be considered. Assuming a value of 2 per cent,

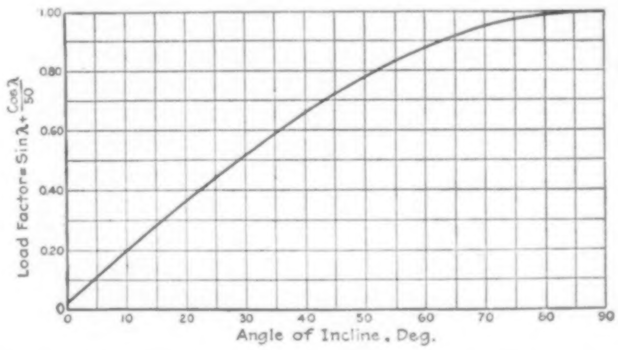

FIG. 3 VARIATIONS IN LOAD FACTOR WITH CHANGES IN ANGLE OF INCLINE

$$F = \frac{(W + wl) \cos \lambda}{50} \qquad [7]$$

Therefore,

$$P = (W + wl)\left(\sin \lambda + \frac{\cos \lambda}{50}\right) \qquad [8]$$

Values for the load factor $\left(\sin \lambda + \dfrac{\cos \lambda}{50}\right)$ for values of λ from 0 to 90 deg. are given in Fig. 3.

MOVING TENSION—ACCELERATION AND RETARDATION

In the case of very slow-moving ropes, the ropes stress in any straight portion will be equal to the load being lifted in the case of a vertical hoist or, on an incline, the tension due to the angle of incline, but there are many cases where rapidly moving ropes are subject to heavy stresses of acceleration or retardation where the factor of safety under static load is reduced very much by quick stops and starts. The value of the stress due to acceleration may be calculated thus:

Let T = time of acceleration
W = weight to be lifted, lb.
w = weight of rope per ft., lb.
E_r = modulus of elasticity of rope
a = acceleration or retardation of load, ft. per sec. per sec.
S = space in which acceleration or retardation is made
V = velocity of load, ft. per sec.
K = kinetic energy of the moving load
k = kinetic energy of the moving rope.

Then

$$K_t = K + k = C\ (W + wl) \qquad [9]$$

where C is a constant by which the load is increased due to kinetic energy, and a factor representing the increase of the total load. Therefore,

$$K_t = \frac{WV^2 + wlV^2}{2g} = \frac{V^2}{2g}(W + wl) \qquad [10]$$

but as

$$V^2 = 2aS$$

$$C\ (W + wl) = \frac{aS}{g}\ (W + wl) \text{ or } a = \frac{Cg}{S} \qquad [11]$$

Also $\quad a^2t^2 = 2\,gC$

and if $t = 1$,

$$a = \sqrt{2gC} = 8.02\sqrt{C}$$

Indirect or Induced Stresses

Bending stress may be of two kinds, direct or reverse. As in the case of solid steel bars, reverse bending is much more severe than direct bending, resulting in greatly reduced life even if the size of sheaves used is fairly large.

Bending stress affects all ropes that are passed over sheaves, which service includes the vast majority of rope installations. Well-developed formulæ in mechanics give the value of this stress for solid round bars bent around a given diameter. When this problem has been considered in connection with wire rope more or less difficulty has appeared due partly to an erroneous conception of the fundamental principles which govern bending stress as applied to wire rope.

Several formulæ have been proposed to calculate the bending stress for wire rope. They all give values much larger than the actual values because the most vital and important factor of the entire problem has been neglected. Wire ropes are manufactured

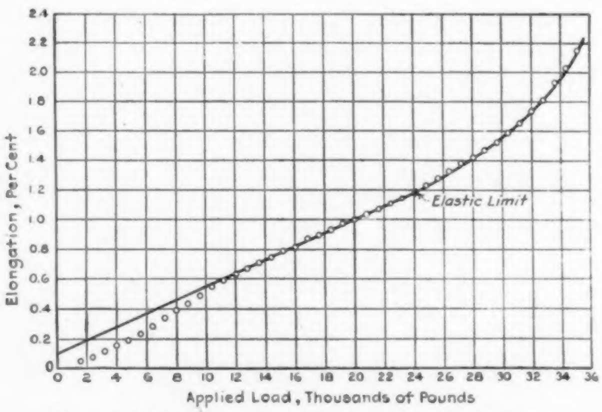

Fig. 4 Load-Elongation Curve of Wire Rope

not from *straight* wires but from *twisted* wires. The values obtained by these formulæ are correct, therefore, only for ropes composed of straight wires. That being the case, they are decidedly incorrect as applied to modern rope, which is made of *twisted* wires. When these formulæ were developed there were no experimental data available to check the results obtained, and they gained credence among engineers probably on account of the reputation of the authors who proposed them. In very similar manner the strength of ropes for many years was calculated as the aggregate strength of all the wires. Experimental data showed this conception to be wrong.

No check tests had been made to determine the modulus of elasticity of complete wire ropes. Owing to the twisting of wires to form wire ropes the modulus of elasticity of a wire rope is much less than that of a solid bar, as illustrated in Figs. 4 and 5, which represent curves of the modulus of elasticity of wire rope with hemp centers. Many other tests on similar ropes have proved conclusively that the modulus of elasticity of six-strand ropes will not run over 12,000,000 lb. and may be somewhat lower. In making such tests it must always be borne in mind that readings of elongation under light load are not as reliable—owing to the yielding nature of hemp core—as the values obtained under heavier loads. The values of the modulus of elasticity should be taken between the points where the stress-strain diagram is approximately a straight line.

Having determined the true value of the modulus of elasticity of a wire rope, we may now proceed to the determination of the bending stress in a wire rope. Considering the Reuleaux formula, $S = Ed/D$, if we replace E, the modulus of elasticity of a solid bar, with E_R, the modulus of elasticity of the rope as a whole, the formula becomes

$$S = E_R \frac{d}{D} \qquad [12]$$

which is the true bending-stress formula for a wire rope.

It should be specially noted that the value of S obtained is the stress per square inch of the greatest strained fiber, since it is the stress in the greatest strained fiber that determines the effect of the bending, just as it does in a beam under load. If we take the value of S and multiply it by the area of the wires in the rope, we obtain the actual bending stress in pounds. The interpretation of this value of the bending stress is important. The bending stress thus calculated shows the value equivalent to a direct tension on the rope.

Calculations may be made which show that over very small sheaves the bending stress by formula $S = E_R d/D$ gives a value greater than the strength per square inch of the material used in making wire rope. This shows that the elastic limit of the fibers of the steel has been exceeded and the rope has taken a permanent set.

The writer developed the formulæ given below for determining the modulus of elasticity of both strands and rope, which checks up with values obtained from a large number of experiments.

Considering first a strand, let E_s be the modulus of elasticity of a strand. Then E_s may be considered as a function of E, or

$$E_s = fE$$

Considering the first concentric strands composed of successive layers of strands, the modulus of elasticity may be determined by considering each layer of wires separately.

Let n = number of wires twisted together in one layer

nd = approximate circumference of pitch circle if the wires are laid straight (n should be in excess of 6)

d = diameter of individual wires composing the ring.

Then $\dfrac{\pi d}{\sin \alpha}$ = exact circumference of pitch circle (wires laid straight)

where α = angle subtended at the center of the ring by the radius of a single wire.

Also, let D_c = outside diameter of circular ring under consideration.

By trigonometry,

$$D_c = Cd$$

where C is an angular function depending upon the number of wires composing the circular ring.

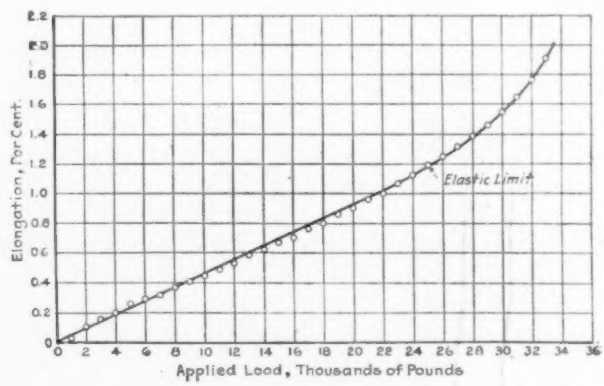

Fig. 5 Load-Elongation Curve of Wire Rope

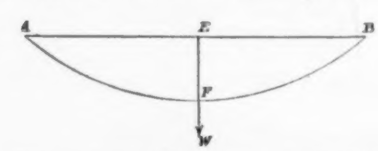

Fig. 6 Stresses in Horizontally Suspended Rope

$\dfrac{d}{\cos \theta}$ = the elongated diameter of the wires normal to the axis of the strand in the twisted arrangement,

where θ is the angle of wire relative to the axis of the strand, i.e., the developed angle of the helix formed by the twisted wire.

By trigonometry $\dfrac{\pi d}{\sin \alpha \cos \theta}$ = circumference of the pitch circle of the annular ring of twisted wires under consideration.

Let E_1 = modulus of elasticity of the annular ring of twisted wires.

$E_1 = fE$ and f is most nearly represented by the formula

$$f = \cos\theta\sqrt{\frac{D_e \sin\alpha\cos\theta}{\pi d}} = \cos\theta\sqrt{\frac{C\sin\alpha\cos\theta}{\pi}}$$

since $D_e = Cd$. Therefore

$$E_1 = E\cos\theta\sqrt{\frac{C\sin\alpha\cos\theta}{\pi}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots [13]$$

If $\theta = 0$, then $\alpha = 90$ deg. and $E_1 = E$.

Considering the quantity outside the radical, as θ grows smaller $\cos\theta$ approaches unity as a limit, hence

$$E\cos\theta = E \text{ at the limit } \theta = 0.$$

Considering the quantity under the radical with $\theta = 0$,

$$\frac{C\sin\alpha}{\pi} = 1 \text{ or } C = \pi$$

and Formula [13] may be written approximately as

$$E_1 = E\cos\theta\sqrt{\frac{D_e}{nd}}$$

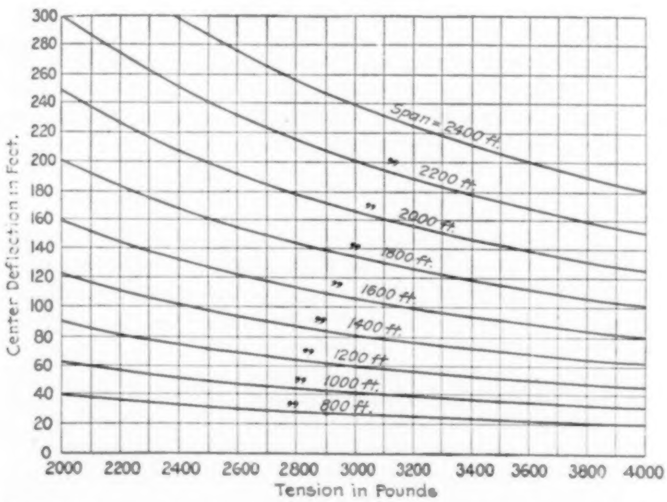

FIG. 7 TENSION IN CABLE SPANS FOR DISTRIBUTED LOAD OF 1 LB. PER FT.

Having determined the value of E_1 for one layer of wires, the value E_s for a strand of any number of layers or wires may be determined as follows:

Let E_1, E_2, E_3, etc., be the moduli of the various circular rings as determined by Formula [13], n_1, n_2, n_3, etc., the number of wires in the corresponding successive rings or layers, and E_s the modulus of elasticity of strand. The effect of various moduli upon the modulus of the strand as a whole will be determined by the number of wires and also by the modulus of the corresponding layer. Dividing this amount by the sum of the number of wires,

$$E_s = \frac{E_1 n + E_2 n_2 + E_3 n_3 + \text{etc.}}{n_1 + n_2 + n_3 + \text{etc.}} \quad \ldots\ldots\ldots\ldots [14]$$

By means of this formula the values of the modulus of elasticity for any type of strand may be determined. If $E_1 = E_2 = E_3$, the modulus of elasticity of any strand $E_s = E_1$.

Considering a rope, the formula for modulus of elasticity takes the same form, only for E_1 we substitute E_s, using the following notation:

ϕ = angle of strands in the rope

N = number of strands in rope

d = diameter of strands

$\dfrac{\pi d}{\sin\beta}$ = exact circumference pitch circle

where

β = angle subtended at center of rope by radius of strand

$\dfrac{d}{\cos\phi}$ = elongated diameter of strand normal to axis of rope in the twisted arrangement

$\dfrac{\pi d}{\sin\beta\cos\phi}$ = exact circumference at pitch circle of strands of rope in the twisted arrangement

E_r = modulus of elasticity for rope

In a similar manner as before

$$E_r = E_s\cos\phi\sqrt{\frac{C\sin\beta\cos\phi}{\pi}} \quad \ldots\ldots\ldots\ldots [15]$$

For a compound rope of several layers of strands the modulus is determined as follows:

Let N_1, N_2, N_3, etc., represent the number of strands in successive layers, E_{r_1}, E_{r_2}, E_{r_3}, etc., the corresponding moduli and E_{mr} the mean modulus of rope. Then

$$E_{mr} = \frac{N_1 E_{r_1} + N_2 E_{r_2} + N_3 E_{r_3} + \text{etc.}}{N_1 + N_2 + N_3 + \text{etc.}} \quad \ldots\ldots\ldots [16]$$

For a compound rope such as one of 6 ropes each having six 7-wire strands,

let Y = angle of rope strands in rope

ψ = angle subtended at center of rope by radius of rope strand

E_R = modulus of elasticity of compound rope

Then

$$E_R = E_r\cos Y\sqrt{\frac{C\sin\psi\cos Y}{\pi}} \quad \ldots\ldots\ldots\ldots\ldots\ldots [17]$$

Table 1 gives values of E_s and E_R, as obtained from Formulæ [14] and [15], and from the results of tests.

TABLE 1 MODULI OF ELASTICITY OF STRANDS AND ROPES

No. of Wires	Approx. Value θ for Outer Layer of Wires	Cos θ	Value of Modulus E_S by Formula	Average of Tests
7	9°–54′	0.9851	19,950,000	20,000,000
19	15°–30′	0.9636	17,760,000	18,000,000
37	16°–33′	0.9586	16,900,000	16,700,000
61	17°– 8′	0.9556	16,600,000	17,000,000

Rope Construction	Approx. Value of θ for Strand Angles	Cos θ	Value of Modulus E_R by Formula	Average of Tests
6 × 7	14°–40′	0.9674	13,000,000	12,800,000
6 × 19	17°–52′	0.9518	11,400,000	11,400,000
8 × 19	20°–44′	0.9352	10,500,000	10,000,000
6 × 37	17°–52′	0.9518	10,800,000	10,400,000
6 × 42	19°–15′	0.9441	7,800,000	7,000,000

In obtaining the values of modulus of elasticity enumerated in Table 1, the value of E has been taken as 27,500,000 lb., since wire used in rope manufacture will not average much higher than 27,500,000. In fact, it may go as low as 25,500,000 and very rarely does it go as high as 29,000,000 lb. Soft bar steels on the contrary have a modulus of elasticity running about 29,000,000. Having determined the value of E_r for a given rope, the bending stress is readily obtained by use of the formula $S = E_r d/D$.

REVERSE BENDING

The value of reverse bending may be determined in exactly the same way as that of direct bending, but its effect is very deleterious, even if the amount is comparably small. If it were possible in the design of a machine not to have any reverse bends, the rope service would be much better; or, if a reverse bend is necessary, let it affect only one part of the rope, in which case the effect might be the same as that of simple bending.

There is one misconception in regard to bending which should be discussed at this point and that is, that it makes no difference whether a bend is 90 deg. or 180 deg. provided it goes around a sheave of a fixed diameter. The stress produced is the same in each case, and with the rope traveling between any two points all of the rope will have to take the bend whether it is 90 deg. or 180 deg. The only thing to be noted is that the bend is effective for a small fraction of a second longer in case it is 180 deg. as compared with 90 deg.

Stresses in a Horizontally Suspended Cable Supporting a Load

In this case a stress is produced in a rope suspended horizontally between two points due to the weight of the rope alone, and any load supported by the rope produces an additional stress which in most cases is not only equal to the load but to several times its value. In the case of a horizontally suspended rope, Fig. 6, assuming the curve to be parabolic in form, we may calculate stresses in a rope as follows:

Let L = total span in feet = AB
D = deflection in feet = EF
W = dead load at point F
w = weight per foot of the cable
S = tension in the cable at F
$X = AE$, position of load W with reference to point A.

Then, for the deflection due to weight of rope alone,

$$S_1 = \frac{wL^2}{8D} \text{ at the center of the span} \quad [18]$$

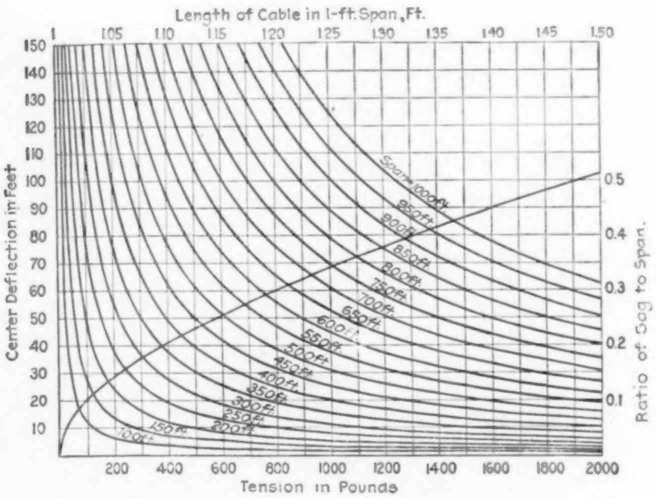

FIG. 8 CABLE TENSION IN TERMS OF CENTER DEFLECTION AND LENGTH OF CABLE FOR DIFFERENT RATIOS OF SPAN AND SAG

Formula [18] is applicable to all cases of uniformly distributed load such as a wire rope or large guy strand used for supporting a lead telephone or power cable, or a bare-copper high-tension feeder cable, at frequent intervals. The value of w must be taken, however, as the total weight per foot of both suspended and supported cable.

The stress due to the weight alone is

$$S_2 = \frac{WL}{4D} \text{ at the center of the span} \quad [19]$$

$$S = S_1 + S_2 = \frac{WL^2 + 2\,WL}{8D} = \frac{L(wL + 2\,W)}{8D} \quad [20]$$

From Formula [20] may be obtained the stress on any cable due to load and weight of cable.

The maximum stress on a cable span is at the supporting points A and B, Fig. 6, when the load is suspended in the center. Tension T at A or B equals tension in center plus the tension due to weight of rope wL and load W times the deflection D, or

$$T = \frac{S + D(wL + 2\,W)}{L} \quad [21]$$

$$= S + D\left(w + \frac{2\,W}{L}\right) \quad [22]$$

Figs. 7 and 8 give the tension in cable spans in pounds for a distributed load of 1 lb. per ft. Fig. 8 also gives the length of cable in a 1-ft. span for different ratios of span and sag.

Preparation of Specification for Wire Rope

Close coöperation between the manufacturer and the engineer in drawing up a specification for wire rope will result in avoiding trouble which sometimes develops in a rope installation, or at least will improve rope service to the user. A few general remarks, therefore, in regard to specifications may not be out of place here.

Whenever possible, specify and use some standard construction of wire rope such as 6 x 7, 6 x 19, 8 x 19, 6 x 37, or 6 x 61. The relative flexibilities of these constructions are in proportion to the diameters of the wires from which they are made. Taking the value of the 6 x 7 rope as 100, the 6 x 19 will be 60; the 8 x 19, 50; the 6 x 37, 43; and the 6 x 61, 33. The sheave diameters will be in proportion to the values for these rope constructions.

Use the strengths shown in the manufacturer's rope catalog of some one of the four standard strengths of steel known by the following trade names:

a Crucible steel
b Extra strong crucible steel
c Plow steel
d Special brand improved plow steel (each maker has a trade name for this brand).

Physical properties of wire are sometimes specified, such as

a Tensile strength per square inch
b Elongation in 10 in.
c Bends over a fixed radius or proportionate radius
d Torsion test in 6- or 8-in. length.

Tensile Strength. Considering these in order, it is seen that, taking a rope of a given diameter and metallic sectional area and allowing for the loss of efficiency due to angle of lay of wires, it will have to have at least a certain strength per square inch in order to meet the required breaking strength.

Elongation. The elongation of rope wire is not very great as compared to annealed wire and the diameter of the wire is the determining factor. A fixed value for elongation covering all sizes of rope wire is unfair as well as untrue to actual conditions of steel manufacture.

Bends. Bends are sometimes specified on rope wire, the object being to eliminate any brittle wire, but no manufacturer would knowingly permit a single piece of brittle wire to be used in rope construction, as all wire would be tested when finished to eliminate brittleness. Rope wire will stand approximately six bends of 90 deg. alternately to right and left over a jaw with a radius equal to twice the diameter of the wire being bent.

Torsion Test. A torsion test in 6 or 8 in. is used by most wire manufacturers to test the uniformity of rope wire. Some rope specifications call for a test for torsion on wires to be used in rope. While it should not be necessary to specify this, still ungalvanized rope wire should stand in 8 in. as many twists as are obtained by dividing the constant 1.8 by the diameter of wire in inches, and proportionate twists in shorter lengths.

Factors Affecting Rope Service

One problem that is intimately linked up with rope service is the question of sheave diameter and the kind of bending to which a rope is subjected. Reverse bending should be avoided in every possible case as it has a very bad effect upon the durability of a wire rope.

For derricks the sheave diameter nowadays rarely exceeds 20 to 30 times the diameter of rope used, which is usually 6 x 19 or 8 x 19 construction. Hoisting machinery for coal towers, clamshell buckets for ore and coal handling are proportioned about forty times the rope diameter for 6 x 19 rope. Ladle cranes in steel mills use sheaves 30 times the rope diameter for 6 x 37 rope. Mine hoists use sheaves and drums from 60 to 100 diameters for 6 x 19 rope, and these are probably the most liberally proportioned of any machinery. Lift bridges have sheaves and drums 50 to 80 times the rope diameter for 6 x 19 rope.

One point that seems to have been lost sight of in designing machinery using large sizes of rope which require large diameters of sheaves and drums, is that in place of 6 x 19 rope it is possible to use 8 x 19, 6 x 37 or 6 x 61 rope and reduce the diameter of both sheaves and drums to more reasonable proportions, and still not have any greater bending stress in the rope. Crane builders have for years been using the 6 x 37 rope with good success and the writer would recommend for general hoisting work (excepting mines) that for ropes larger than $1\frac{1}{2}$ in., 6 x 37 rope be used, and for those larger than 2 in. that 6 x 61 rope be employed.

Another factor affecting rope service is the personal equation of the operator who is to handle the wire rope. The skill with which any rope is handled coupled with freedom from sudden jerks or quick stops vitally affects its life. Similarly, the external wear or abrasion of the wires composing the rope influences the durability of the rope. Properly aligned sheaves, loads that are not excessive, and absence of any points where friction would cause undue wear, will all contribute to longevity of rope service. If the external wear is excessive, the rope maker can only partially overcome this difficulty by the use of stronger and harder grades of steel. Of the four grades of steel mentioned above, crucible is the softest and improved plow steel the hardest.

It might be thought at the first glance that all it is necessary to do to solve the problem of abrasion is to use the hardest possible steel. This is not necessarily true, because each of the four grades has physical characteristics that are possessed by the others, only in a greater or lesser degree. If, therefore, in the design of a machine requiring wire rope it is found that crucible steel will give an ample factor of safety and sheaves and drums are of suitable size so that this grade of rope may be readily supplied, then the chances are that crucible steel will be the best grade of rope to be used, bearing in mind always the question of abrasion. Such is the case in the vast majority of mining operations in the United States. Some mining operations are, of course, using plow steel, but the bulk of the coal-mining industries use crucible-steel rope, or at the most the extra strong crucible, with here and there an occasional plow-steel rope. In other metal mines both crucible- and plow-steel ropes are being employed. In some cases where loads have been increased the grade of rope employed has been changed from crucible or plow steel in order to take care of the increase in load. Iron-ore mines, for instance, are generally using the plow-steel grade of rope because of the heavy loads lifted and the grinding action of the iron-ore dust which becomes more or less intimately attached to the rope in the process of hoisting.

Corrosion is another element which affects the service factor. This is due to the rope's being subjected to the action of the elements or an acid mine water, sulphurous gases, etc. The higher the grade of steel, the more rapid will be the corrosion resulting from such exposure. Good lubrication where it is possible to maintain it will have a large influence in counteracting the corrosive effect, but in some cases it is next to impossible to get any lubricant to stay on the rope, and in such cases only the resistant action of the steel itself to the corrosive effect is left. When this corrosion has reached the point where pitting has reduced the metallic sectional area of the wires and they have started to break, then the life of the rope is practically gone.

Ascertaining the proper value of all stresses, together with the choice of a reasonable and safe factor of safety, will contribute largely to the longevity of wire rope under any set of conditions.

THE COOLING LOSSES IN INTERNAL-COMBUSTION ENGINES AS AFFECTING THEIR DESIGN

By C. A. NORMAN,[1] COLUMBUS, OHIO

THERE is considerable evidence that a great part of the heat loss to jacket water in an explosion engine occurs, not during the expansion stroke, but rather in the exhaust passages. Coker found by direct measurement a temperature drop of 150 deg. cent. (270 deg. fahr.) between the gas in the cylinder at the end of the expansion stroke and the gas in the exhaust pipe. Dugald Clerk found indirectly that of a total measured jacket loss of 25.4 per cent, about 16 occurred in the cylinder, and consequently 9.4 per cent in the exhaust passage. Losses in the exhaust passages, however, have no influence on the thermal efficiency of the engine. In order to arrive at the influence of varying proportions and speeds on the efficiency it would be necessary to determine separately the losses during the expansion stroke for a whole series of engines, varying only one factor at a time. No such investigation has to the knowledge of the writer been undertaken.

The formula for cooling loss developed later by the author from the published work of Clerk and others, while based on purely theoretical considerations, has nevertheless been found to represent fairly both the results of careful experiments and general experience, and its presentation at this time would therefore seem to be abundantly justified.

Method Employed by Dugald Clerk in His Experiments

Clerk equipped an ordinary gas engine with a contrivance enabling him momentarily to close the inlet and exhaust valves while the engine continued to run. A series of recompressions and reëxpansions of the same burned charge took place in the cylinder. A sample diagram of these fluctuations is given in Fig. 1.

With no cooling and no friction losses the recompression ought always to carry the gas temperature back to its value at the beginning of the previous expansion. As a matter of fact, Fig. 1 shows a constant falling of the temperature from point B to points D, F, H, etc. By means of calculation or determination of the temperature at one point, definite temperature values can be assigned to all the other maximum- and minimum-pressure points on the diagram and an estimate of the actual temperature drops and the average temperatures during the strokes can be made. With the aid of the speed of the engine it is also possible to give the results in terms of reduced temperature drops per second corresponding to certain average temperatures. The results are given in the form of the curves reproduced from Clerk's work in Fig. 2.

These curves show reduced temperature drop per second on the cold engine running light at 120 r.p.m. for a full expansion stroke (a) and for the upper 3/10 expansion stroke (a'). Also for the hot engine running light at 160 r.p.m. for the full expansion stroke (b) and loaded during the upper 3/10 expansion stroke (b'). The intersection of the curves with the temperature axis gives the mean temperature of the wall.

The curves in Fig. 2 give temperature drop, not heat loss. The expansion work in an engine cylinder is directly connected with the temperature by means of the specific heat. On the other hand, the work can be directly evaluated from the indicator diagram. In this way the specific heat of the gas in the cylinder at various temperatures can be ascertained.[1] Clerk gives the values found in Table 1.

Table 1 gives a striking illustration of the increase of the specific heat with the temperature. This increase is not uniform, however. It is considerable at lower temperatures, but almost nil at higher temperatures. Clerk in his original paper deems this behavior partly due to delayed combustion and hence considers his specific-heat values as merely "apparent."

Very thorough investigations of the specific heats of gases have been carried out by Nernst and his pupils.[2] From these it would appear that only carbon dioxide with certainty behaves in the manner indicated by Clerk's experiments. The specific heat of all other common gases, even that of superheated steam of sufficiently

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[1] See Proceedings of the Royal Society, A. vol. 77, p. 499.

[2] See Nernst, Theoretische Chemie, 1913, p. 267.

high temperature, shows rather a linear increase with the temperature. For the mixture used by Clerk the specific-heat values he gives seem to be too high, at least at lower temperatures. This is the opinion also of the Gaseous Explosion Committee of the

TABLE 1 APPARENT SPECIFIC HEAT (INSTANTANEOUS) AT CONSTANT VOLUME, C_V, EXPRESSED IN FT-LB. PER CU. FT. OF WORKING FLUID AT 0 DEG. CENT. AND 760 MM.

Temperature, deg. Cent.	C_V Ft-Lb.	Temperature, deg. Cent.	C_V Ft-Lb.
0	19.6	800	26.2
100	20.9	900	26.6
200	22.0	1000	26.8
300	23.0	1100	27.0
400	23.9	1200	27.2
500	24.8	1300	27.3
600	25.2	1400	27.35
700	25.7	1500	27.45

British Association. Yet, as will be seen below, the deviations are not very great, considering the accuracy possible. By means of his heat values Clerk has succeeded in accounting very satis-

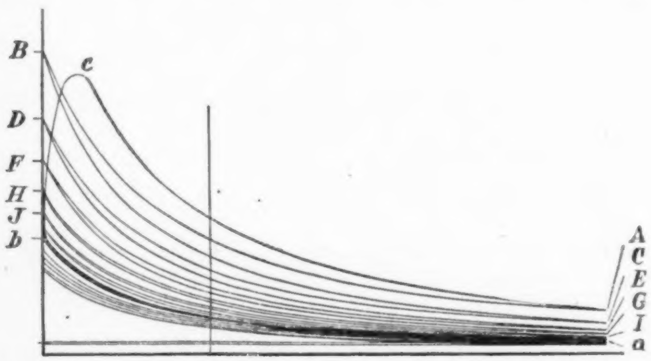

FIG. 1 CLERK DIAGRAM OF EXPLOSION AND ALTERNATE COMPRESSION AND EXPANSION OF HOT GASES IN ENGINE CYLINDER

factorily and in a new and striking manner for the heat balances in several combustion engines. In the illustrative examples figured in this paper these values have at times been used. This can be done without question when only general laws for design are to be established.

Clerk gives the average composition of his combustion gas as follows:

	Volumes
Steam (assumed gaseous)	11.9
Carbon dioxide	5.2
Oxygen	7.9
Nitrogen	75.0
	100.0

The molecular weight of this mixture would be 27.96, or practically that of pure nitrogen, and the weight of 1 cu. ft. at 0 deg. cent. and 760 mm., 0.078 lb. The specific heat for the mixture at various temperatures is given in Table 2, in customary units, the values having been derived from the Clerk and the Nernst values.

The difference between the two series of specific-heat values given in Table 2 amounts to about 10 per cent in the middle of the range, but is barely 1 per cent at atmospheric temperature and less than 2.5 per cent at 1500 deg. cent. (2700 deg. fahr.). With the aid of Clerk's specific heats the cooling curves in Fig. 3 have been obtained. These curves give the cooling loss during the whole expansion stroke, reduced, however, to heat units per unit weight of gas per second. If, then, we compute the work theoretically obtainable from 1 lb. of gas with the temperatures and the expansion occurring, and if we compute the heat neces-

TABLE 2 SPECIFIC HEAT OF CLERK'S WORKING MIXTURE

Temperature		Specific heat. B.t.u. per lb. or cal. per kg.	
Deg. cent.	Deg. fahr.	According to Clerk	According to Nernst
32	0	0.180	0.178
212	100	0.192	0.183
392	200	0.202	0.187
572	300	0.211	0.192
752	400	0.219	0.196
932	500	0.228	0.201
1112	600	0.231.	0.205
1292	700	0.236	0.210
1472	800	0.240	0.214
1652	900	0.244.	0.219
1832	1000	0.246	0.223
2012	1100	0.248	0.228
2192	1200	0.250	0.232
2372	1300	0.251	0.237
2552	1400	0.2515	0.241
2732	1500	0.252	0.246

sary to raise 1 lb. of gas from the temperature at the end of compression to the temperature at the end of the explosion, we can derive the actual expansion work as well as the percentage cooling loss. This, however, applies only to the Clerk engine.

APPLICATION OF CLERK'S HEAT-DROP CURVES TO OTHER ENGINES

Influence of Surface-to-Volume Ratio.—Clerk's experimental engine had the following dimensions:

Cylinder diameter, in.	14
Stroke, in.	22

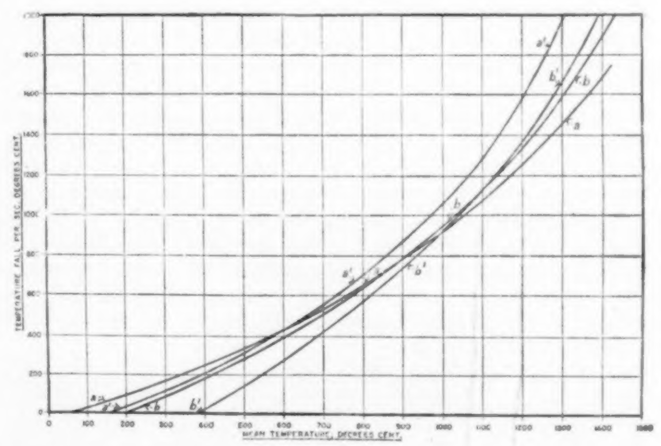

FIG. 2 TEMPERATURE DROP INCURRED PER SECOND AT DIFFERENT MEAN TEMPERATURES CALCULATED IN TIME. EACH LINE IS THE MEAN OF THREE CARDS UNDER THE GIVEN CONDITIONS

120 r.p.m. Cold { (a) Whole stroke; (a') Upper 1/3 stroke   160 r.p.m. Hot Load 50 b.h.p. { (b) Whole stroke; (b') Upper 1/3 stroke

Total cylinder volume with full-out piston, cu. ft.	2.41
Total cooling surface with full-out piston, sq. ft.	11.2
Sq. ft. of cooling surface per cu. ft. of volume	4.64

Now, the most simple assumption to make with regard to cooling losses is that they vary directly as the ratio of surface to included volume. For this assumption there is considerable support in the results of experiments with explosions in closed vessels. Table 3 gives data on the surface and capacity of the vessels used by several different experimenters, and Table 4, values of the temperature drop in the same vessels as recorded by Clerk.

The values in Table 4 have been plotted in Fig. 4. The experiments were carried out at widely differing places and times by

TABLE 3 EXPLOSION EXPERIMENTS WITH CLOSED VESSELS

Reference No.	Experimenter	Capacity of vessel, cu. ft.	Interna surface of vessel sq. ft.	Ratio of surface to volume, sq. ft. per cu. ft.
1	Hopkinson (large vessel)...........	6.2	17.3	2.79
2	Bairstow and Alexander Hopkinson (small vessel)................	0.82	5.02	6.12
3	Hopkinson (small vessel)..........	0.684	4.33	6.33
4	Clerk (first vessel)...............	0.183	1.79	9.78
5	Massachusetts Institute Technology	0.180	1.79	9.94
6	Clerk (second vessel).............	0.150	1.60	10.65

different experimenters, using different methods, with vessels of differing shapes. It should not cause any surprise that the points are scattered. Nevertheless, it can hardly be denied that they are more naturally represented by straight lines, as shown, than in any other manner.

As far as experimental evidence goes, it then certainly seems to counsel the assumption of direct proportionality between heat loss per unit time and the ratio of surface to included volume. For geometrically similar vessels this ratio varies inversely as the linear dimensions. For similar engines running at the same number of revolutions the cooling losses would then vary inversely as the cylinder diameter. This has led to the conclusion that the cooling losses could be reduced almost to zero by employing sufficiently large dimensions. How unjustified this is will appear after some further scrutiny.

Influence of Speed. In the derivation of the heat-loss curve

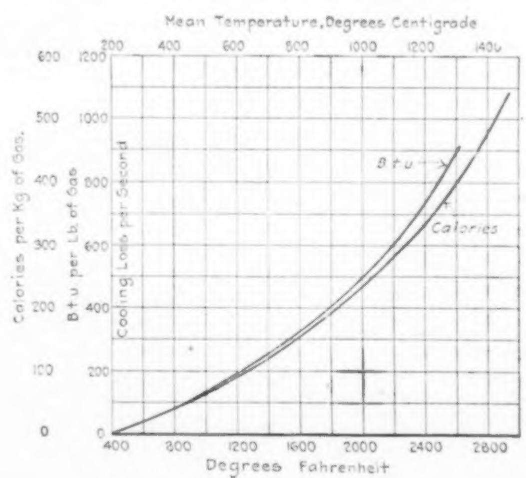

FIG. 3 COOLING LOSS PER SECOND AND UNIT WEIGHT OF GAS FOR FULL STROKE IN CLERK EXPERIMENTAL ENGINE

from Clerk's experiments it has been tacitly assumed that the heat loss varies directly as the time. No other assumption with regard to heat transfer has ever been made. With all other conditions equal, the heat loss in an engine should then vary inversely as the r.p.m. It is important, however, to note that all other conditions should be equal. It is known that if an engine is speeded up, something may be gained in efficiency, yet not as much as should be expected if the heat loss dropped in direct proportion to the increase in speed. The reason for this is often given as increased turbulence with increased speed. This would, of course, increase the convection losses. If the valves are correctly located and correctly proportioned there should be no more turbulence at high speed than at low speed, unless the turbulence is intentionally increased in order to accelerate combustion.

For the same engine, an increase in r.p.m. means an increase in piston speed and an equal increase in gas velocity along the walls. The old idea was that the coefficient of heat transfer from gases increased directly as the square root of the rubbing velocity of the gas. We can probably do no better in the present connection than adhere to this old idea, even though it expresses the relations somewhat too simply. We should then put the heat loss directly proportional to the square root of the piston speed. Consequently, if the known heat loss of a certain engine be denoted by L_o, and its surface-to-volume ratio and its piston speed, and r.p.m. by R_o, V_o and N_o, respectively, then for another similar engine with values R, V and N, working under the same temperature conditions the heat loss

$$L = L_o \times \frac{R}{R_o} \times \frac{N_o}{N} \times \sqrt{\frac{V}{V_o}} \quad \ldots\ldots\ldots\ldots [1]$$

In the form just given the formula is serviceable only for comparing with each other engines working under similar temperature conditions, with similar fuels. It does not take into account variations in expansion ratio, or in maximum temperature; nor does it give absolute heat losses in heat units per unit weight of gas. It can easily be given this added range of usefulness by con-

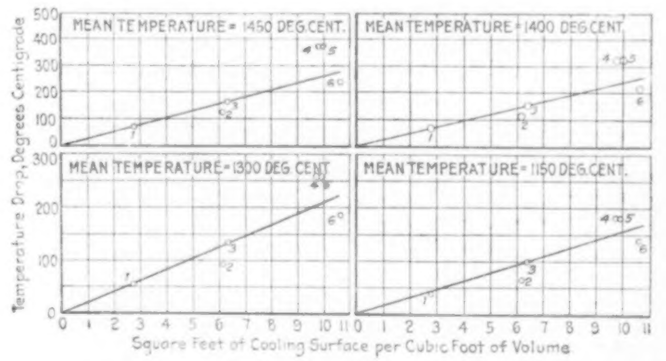

FIG. 4 EXPLOSION EXPERIMENTS WITH CLOSED VESSELS: DROP IN TEMPERATURE IN 0.05 SEC. AT MEAN TEMPERATURES GIVEN. PRESSURE BEFORE EXPLOSION, ATMOSPHERIC

necting it with the heat losses per second per unit weight of gas given for varying mean temperatures for the Clerk engine by the curve in Fig. 3.

Assuming a certain maximum temperature, or calculating it approximately with the aid of the specific heats given in Table 2,

TABLE 4 DROP IN TEMPERATURE IN 0.05 SECOND AT MEAN TEMPERATURES GIVEN, DEG. CENT.

Pressure before explosion in all vessels, atmospheric

Reference No.	Ratio of surface to volume, sq. ft. per cu. ft.	Drop in temperature in 0.05 sec. at mean temperature of			
		1450 deg. cent.	1400 deg. cent.	1300 deg. cent.	1150 deg. cent.
1	2.79	80	68	52	38
2	6.12	127	114	93	65
3	6.33	166	153	131	100
4	9.78	378	327	257	182
5	9.94	372	327	257	182
6	10.65	238	216	184	138

it is possible then to estimate from the expansion ratio of the engine the temperature drop during the expansion by the use of an assumed polytropic exponent. From this we get close enough for our purpose the mean temperature during expansion as an arithmetic average. The corresponding heat loss C is read from the curve in Fig. 3 and it is the loss in B.t.u. per lb., or cal. per kg. of gas used for an expansion stroke lasting one second. To get the loss for any other duration of stroke it is simply necessary to multiply C by the actual duration in service. If the actual r.p.m. is N, this duration is $30/N$. The surface-to-volume ratio in the Clerk engine was 4.64 sq. ft. per cu. ft., and the piston speed at 160 r.p.m.—the speed at which the curve ap-

plies—586 ft. per min. Consequently, for any engine of surface-to-volume ratio R and piston speed V the expansion cooling loss in heat units per unit weight of gas used is

$$L = C \times \frac{30}{N} \times \frac{R}{4.64} \sqrt{\frac{V}{586}}$$

or

$$L = 0.267(CR/N)\sqrt{V} \qquad [2]$$

In Formula [2] R is expressed in sq. ft. per cu. ft., V in ft. per min., and N in r.p.m., while C can be either in B.t.u. per lb., or cal. per kg., or in any other units for which a C curve is available. If R should be given in sq. in. per cu. in., which is more convenient in most cases, then

$$L = 3.2(CR/N)\sqrt{V} \qquad [3]$$

where V is the piston speed in ft. per min. as is customary.

Application of the Cooling-Loss Formula to Actual Cases

Influence of Absolute Dimensions on Cooling Losses. Assume in the first instance that the piston speed does not vary. Particulars of series of such engines for a piston speed of 1000 ft. per min. and a bore-to-stroke ratio of 1:1.5 are given in Table 5.

TABLE 5 ENGINES WITH PISTON SPEED OF 1000 FT. PER MIN. AND STROKE-TO-BORE RATIO OF 1.5

Diameter, in.	3	10	15	30	42
Stroke, in.	4.5	15	22.5	45	63
R.p.m.	1333	400	266	133.3	95

In this case the r.p.m. varies inversely as the diameter, and so does the surface ratio. Consequently for the same C, L is constant. Thus, as far as the formula for the same expansion ratio and the same maximum temperature goes, the cooling losses and hence the indicated efficiency of these engines would be the same for all dimensions. Actually in order to avoid cracking of the metal, the cooling will have to be much more efficient for the larger engines. If they are double-acting, then even the pistons will be water-cooled. Even so, the maximum temperatures and maximum pressures will have to be kept down. The larger engines will therefore have a tendency to be rather less efficient than the smaller ones. On the other hand, with very high values of N the combustion is likely to consume a large part, if not the whole, of the stroke. In many cases, in fact, a good deal of the combustion will take place in the exhaust pipe. This can be prevented by extremely efficient carburization and ignition. Yet, on the whole, the likelihood is that, with the same compression, the best efficiencies will be found in the middle of the range. This would seem to be borne out by experience.

It may, however, be said that unvarying piston speed for all dimensions does not correspond to actual conditions. In some aeroplane and automobile engines piston speeds are found approaching, if not exceeding, 2000 ft., while it might perhaps be conservative to let the piston speed of very large engines remain below 750 ft. Suppose that at the large-size end the piston speed is half of what it is at the small-size end. The number of revolutions at the large-size end would be only half of what it would have to be to limit the cooling loss to its value at the small-size end, piston speeds being equal. This would tend to make the cooling loss twice as large at the large-size end. On account of the lower value of the piston speed this loss is reduced in the ratio of $\sqrt{2}$. The upshot is that the loss would be about 40 per cent greater for the large size.

There is then absolutely no reason to look for high efficiency in large dimensions. High speed, even though connected with high piston speeds, is preferable, even from the pure efficiency point of view—provided the combustion can be effected satisfactorily.

Influence of Varying Stroke-to-Bore Ratio. In this paragraph it will be assumed that the change in stroke-to-bore ratio is not consequent upon a change in expansion ratio. The question is: With a given expansion ratio and temperature range, how should a cylinder be proportioned for best efficiency? A basic cylinder of 5 in. diameter and 6 in. stroke, with the same total volume and the same clearance volume for all other proportions, will be considered. The expansion ratio may be 5—that of the Clerk engine; the speed, 1200 r.p.m.; the piston speed will vary from case to case.

Using Formula [1] the conditions found are those recorded in Table 6.

TABLE 6 ENGINES WITH UNVARYING VOLUME AND VARYING STROKE-TO-BORE RATIO

Ratio, stroke to bore	1.0	1.2	1.4	1.6	1.8	2.0	2.5
Diameter, in.	5.3	5.0	4.74	4.53	4.35	4.2	3.9
Stroke, in.	5.3	6.0	6.63	7.25	7.81	8.4	9.75
R, sq. ft. per cu. ft.	12.7	12.8	13.1	13.3	13.5	13.8	14.3
Piston speed, ft. per min.	1060	1200	1326	1450	1562	1680	1950
Cooling loss, per cent (for Clerk engine 16 per cent)	7.85	8.4	9.05	9.6	10.1	10.8	12.0

The cooling loss increases regularly with increasing stroke-to-bore ratio. The absolute magnitude of the loss is small and the extreme variation changes the thermal efficiency by only 4 per cent. However, this 4 per cent means from 15 to 20 per cent saving in fuel. In an aeroplane 1 lb. of weight would be saved in fuel for a 10-hr. flight for every hp. of the engine output. This is not negligible, and will count more and more as longer and longer flights over sea, or over enemy territory, are attempted.

Influence of Varying Stroke-to-Bore Ratio Consequent on Varying Expansion Ratio. The next step is to investigate the influence of varying expansion ratio on engines of the same output and the same speed, the increase in expansion being brought about by lengthening the stroke. With increased compression and increased stroke the output per sq. in. of piston area will increase for the same number of revolutions. To obtain equal output the cylinder diameter will have to decrease with increased expansion ratio, as indicated in Table 7.

TABLE 7 INFLUENCE OF VARYING EXPANSION RATIO ON ENGINES OF THE SAME OUTPUT AND THE SAME SPEED

Volumetric expansion ratio	3	5	7	9
Cylinder diameter, in.	5	4	3.5	3
Stroke, in.	5	6	7	7.5
Ratio, stroke to bore	1	1.5	2	2.5
Surface-to-volume ratio, R, sq. ft. per cu. ft.	13.3	15.5	16.7	19.0
Piston speed, ft. per min.	1000	1200	1400	1500
Max. temperature, assumed, deg. fahr.	3270	3270	3270	3270
Max. temperature, assumed, deg. cent.	1800	1800	1800	1800
Final temperature of expansion, deg. fahr.	2240	1850	1630	1470
Final temperature of expansion, deg. cent.	1227	1007	887	802
Heat loss, B.t.u. per lb. of gas	100	103	108	118
Heat loss, cal. per kg. of gas	56	57	60	65
Indicated work, approx., B.t.u. per lb. of gas	171	337	271	297
Indicated work, approx., cal. per kg. of gas	95	132	151	165

Polytropic exponent in computation of temperature drops, 1.3; compression work assumed equal to 30 per cent of expansion work.

As Table 7 shows, while the cooling loss increases 18 per cent, the indicated work increases 74 per cent. The value of high expansion, even though gained by increased stroke-to-bore ratio and decreased cylinder diameters, is hereby clearly demonstrated. For average conditions, however, a high-expansion engine would be more efficient with a large diameter and a short stroke than with a small diameter and a long stroke.

Character of the Combustion in High-Speed Engines. In Table 7 the cooling losses and the indicated work are given in heat units per unit weight of gas. If to obtain percentages an attempt were made to calculate the thermal efficiency of the engine by reference to the heat supplied during combustion, some very astonishing figures would result, such as those in Table 8. Here the maximum temperature has been assumed equal to 3270 deg. fahr. (1800 deg. cent.), in all cases and the mechanical efficiency equal to 0.85.

TABLE 8 APPARENT SHAFT EFFICIENCIES FOR ENGINES IN TABLE 7

Volumetric expansion ratio	3	5	7	9
End temperature of compression, deg. fahr. abs	1000	1170	1290	1390
End temperature of compression, deg. cent. abs	556	648	718	773
Temperature rise to 3730 deg. fahr. abs	2730	2560	2440	2340
Temperature rise to 2073 deg. cent. abs	1517	1425	1355	1300
Heat required, approx. ($C_v = 0.225$), B.t.u. per lb. of gas	615	576	550	525
Heat required, cal. per kg. of gas	342	320	305	292
Shaft thermal efficiency from indicated work in Table 7 (mech. eff. 0.85)	0.236	0.35	0.42	0.48

It is evident that, even though 7 and 9 may be unusual expansion ratios in actual engines, we can never hope to attain brake efficiencies as high as those in Table 8. In arriving at these efficiencies no use has been made of the calculated cooling losses; we have simply taken a polytropic-expansion exponent equal to 1.3 and assumed that all heat is added before the expansion commences to take place.

Clerk in his paper before the Royal Society concludes from his experiments on an engine running at only 160 r.p.m. that some combustion is proceeding even during his first reëxpansion, i.e., after the whole normal expansion stroke and a whole intervening compression stroke. All experiments with closed vessels show gaseous explosions to take certainly not less than $\frac{1}{40}$ sec., and this only with over-rich mixtures. With normal mixtures, it takes a much longer time than that to reach the maximum pressure. Turbulence accelerates combustion very much. Yet such direct experiments as we have seem to show that with normal mixtures even a turbulent combustion would take all of $\frac{1}{40}$ sec. One-fortieth of a second, however, is exactly the time occupied by the whole expansion stroke of an engine running at 1200 r.p.m. We have then absolutely no reason to assume that the combustion is complete before the expansion commences. In the series of engines just considered, it is far more reasonable to assume that it continues during the whole expansion stroke.

Assuming this we might approach the conditions actually obtaining by figuring with an isothermal expansion. During such an expansion all the heat added passes directly into work. Assume a temperature of 1600 deg. cent. (2912 deg. fahr.) to obtain during the expansion, then with an expansion ratio of 5 we find for the corresponding engine in Table 7 the values given in Table 9.

TABLE 9 SHAFT EFFICIENCY AND COOLING LOSS OF ENGINE OF TABLE 7 WITH EXPANSION RATIO OF 5, ASSUMING ISOTHERMAL EXPANSION

	B.t.u. per lb.	Cal. per kg.
Isothermal expansion work (gas constant = 0.071)	385	214
Heat added between compression temperature (708 deg. fahr., 375 deg. cent.), and max. temp. ($C_v = 0.225$)	496	276
Cooling loss, estimated	162	90
Total heat supplied	1043	5803
Compression work (exponent = 1.3)	104	58
Indicated work	281	156
Shaft efficiency (mech. eff. = 0.85)	0.229	0.225
Cooling loss, per cent	15.5	15.5

The shaft efficiency is now about what would be expected from an engine of this size and speed, and the cooling loss is considerably increased. The main reason for the lowered efficiency, however, is not cooling loss, but delayed combustion. To increase efficiency in explosion engines running at very high speeds, the main prerequisites are extremely efficient carburation, extremely efficient ignition, and *perhaps*, if feasible, some means for increasing the turbulence during combustion. It would hardly be good practice to increase turbulence by means of greater gas velocities and greater throttling losses in valves.

DAYLIGHT VS. SUNLIGHT IN SAWTOOTH-ROOF CONSTRUCTION

By W. S. BROWN, PROVIDENCE, R. I.

MANY processes of manufacturing require for best results, natural illumination consisting of sufficient and well-diffused daylight with, at the same time, however, the important limitation that little or no direct sunlight shall fall upon the working plane. That is, there is a sharp distinction between daylight and sunlight and their relative desirability. The former consists of illumination by reflected and refracted light, properly designed fenestration, resulting in an evenly distributed, well-diffused light with consequent lack of sharp shadows and contrasts. The latter, or illumination by direct sunlight, is objectionable for many reasons of varying relative importance, such as the following: Its heating effect, especially in warm, southern climates; its color which has a sensation value containing a greater proportion of red rays than daylight; its actinic effect upon materials used in the manufacturing processes; and the fact that it is unidirectional and of excessive intensity resulting in glare, sharp shadows and contrasts.

Diffusion of daylight in sawtooth buildings is obtained by placing the sawteeth so that the glass or lighting area faces the northern sky; sufficient intensity being dependent, among other things, upon the size and slope of the lighting area. Evenness of distribution is procured by properly apportioning the lighting areas. The amount of direct sunlight admitted daily, the time of its admission, and its duration are evidently dependent upon three considerations, the last two of which may be varied within certain practical limits. They are:

a Day of the year, determining as it does the sun's path across the sky

b Direction in which the lighting area faces as regards the points of the compass

c Slope of the lighting area.

For a given lighting area, a variation in its slope is accompanied by a very appreciable change in the amount of daylight admitted. That is, as the pitch of the lighting area is made steeper, the amount and duration of direct sunlight entering the building is lessened, but only at the expense of the general illumination. Conversely, as the slope of the lighting area is decreased, the intensity of daylight is correspondingly increased, but there also is concurrent therewith a greater amount and duration of direct sunlight. The question then becomes: How steep should this slope be? What is the proper balance between the two contending requirements of little sunlight and much daylight? Also at what time of day will direct solar rays fall upon the working plane, in what locations and volume, and for how long a period?

Naturally, no general answer can be given, but each individual problem should be worked out only after careful study has been made of the particular conditions and requirements which have to be met, not excluding first cost. In the Southern States, for example, the tendency is to adopt a more nearly vertical lighting area than in the northern part of the United States or Canada, on account of the greater altitude of the sun and its intense heat. Occasionally it has been found advantageous to so locate machinery as to avoid any direct sunlight during the working hours.

[1] Industrial Engineer, F. P. Sheldon & Son. Assoc-Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

With a view, therefore, to clearing up such questions as these, the writer's firm, F. P. Sheldon & Son, undertook to work out, in connection with what empirical data they already had, a rational method of design for sawtooth-roof construction.

The subject is necessarily divided into two closely related parts, the first concerning *direct sunlight*, its amount, time of admission, duration, and location on the working plane; the second relating to intensity of *daylight* upon the working plane.

PART 1 ORIENTATION OF SAWTOOTH BUILDINGS AND SLOPE OF THE LIGHTING AREA AS RELATED TO REQUIREMENTS OF LEAST DIRECT SUNLIGHT

In the practical problem of the sawtooth roof, the effective slope or *vertical angle* of the lighting area, on account of projecting jets, gutters, and sash rails, and the interference of roof rafters, etc., is *greater* than the pitch of the glass itself; this often amounts to as much as 7 or 10 deg. Similarly the *horizontal angle* or bearing of the lighting area with respect to the sun's rays may be greater or less than the nominal angle on account of projecting vertical sash bars, etc. This difference often amounts to as much as 5 or 8 deg.

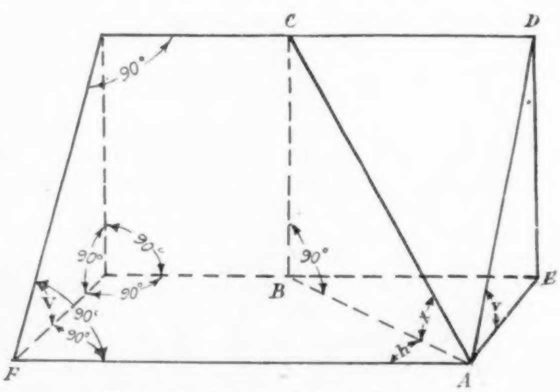

FIG. 1 PATH OF DIRECT SUNLIGHT

The position of the sun at any given time depends upon the latitude of the place, time of day, and calendar date, and may be obtained from standard altitude and azimuth tables. Knowing these, the time of admission and duration of direct sunlight for any day of the year may be calculated as follows:

In Fig. 1, let the plane determined by the three points, A, C and D represent the lighting-area plane, and let points A, B and E define a plane parallel with the horizon. These two planes intersect in line AF. The acute angle v is then the effective slope or vertical angle of the lighting-area plane.

Also let line AB represent the horizontal direction or bearing of the sun with respect to the building at any assumed calendar date and time. That is, angle h is the difference between the sun's true bearing or azimuth and the true corrected bearing or azimuth of the lighting-area ridges, each azimuth being read easterly or westerly from north, according to whether morning or afternoon conditions are being computed.

Now pass plane ABC through AB perpendicular to plane ABE cutting the lighting-area plane ACD in line CD. By construction this plane also contains the sun's altitude line through point A. Consequently, it is evident that if vertical angle x is greater than the altitude of the sun, a condition of total shade exists within the building at the given time. And contrarywise, if x is less than the solar altitude, the sun is in front of the plane of the lighting area and some direct sunlight is entering the building.

Now, to find x in terms of v and h (see Fig. 1),

$$AE = ED \cot v$$

and $$AB = ED \cot x$$

and $$\cos (90 - h) = \frac{AE}{AB}.$$

Substituting in the last equation the values of AE and AB,

$$\cos (90 - h) = \frac{\cot v}{\cot x}$$

whence, $$\sin h = \frac{\cot v}{\cot x}$$

and $$\tan x = \sin h \tan v \qquad [1]$$

From the above equation exact information may be obtained as to the time of admission of direct sunlight and the number of hours of its duration. The solution of a numerical example will illustrate the method of procedure.

A NUMERICAL EXAMPLE, SUNLIGHT CONDITIONS

Given a sawtooth building located in north latitude 36 deg. Orientation of building is such that azimuth of sawtooth ridges $= 99° \; 08'$ E. Angle of glass $= 73°$. *Required* to find sunlight conditions on June 10 (sun's declination 23° N.).

By inspection, according to azimuth tables, sunlight will enter the building from sunrise until at least 9:20 a. m. apparent time, because the sun's azimuth up to that time is less than that of the sawtooth ridges. The method now consists in finding by trial at what time the sunlight entirely disappears from the building.

Assume 10:20 a. m., at which apparent time, according to the tables, the sun's azimuth $= 114° \; 08'$ E., and its altitude $64° \; 46'$. Now, $v = 73°$ plus a correction for projecting jets, gutters, etc., as previously explained. (This may be found from detailed section of building and in this case will be assumed as 7°.) Then $v = 73° + 7° = 80°$). Applying the correction as explained above,

$$h = 114° \; 08' - (90° \; 08' - 5°) = 20°.$$

Entering Equation [1],

$$\tan x = \sin 20° \tan 80°$$

whence $$x = 62° \; 43'.$$

Since at this time the solar altitude ($64° \; 46'$) is greater than x, a small angle of sunlight is entering the building. The above process may be repeated with a slightly greater assumed value of h, with the result that within a few minutes all direct sunlight will be found to be entirely excluded from the building.

To obtain afternoon conditions, the operation should be further continued until such time as sunlight is found to reënter as follows:

In this case, instead of assuming the time, and computing h, the reverse method will be pursued and, as a further short cut, it may be reasoned that since the lighting area faces slightly toward the east (that is, N, 9° 8' E.), h at the transition period will be less than in the morning.

The westerly azimuth of the sawtooth ridges is now used for reference with the tables and equals $90° \; 0' - 9° \; 8' = 80° \; 52'$. Try $h = 6°$, at which time the sun's azimuth becomes $(80° \; 52' - 5°) + 6° = 81° \; 52'$, the apparent time being, from the tables 4:34 p. m., and the sun's altitude being from the tables $30° \; 10'$. Entering Equation [1],

$$\tan x = \sin 6° \tan 80°$$

whence $$x = 30° \; 41'.$$

Since x is $0° \; 31'$ greater than the solar altitude, it is evident that no direct sunlight is entering. However, the angular difference is very slight, and if the computations were carried on a step further, sunlight would be found to come in approximately five minutes later.

In this case, then, on June 10 a condition of total shade exists within the building from approximately 9:20 a. m. until 4:34 p. m., *apparent time*. Where the apparent time is different from standard time, the proper allowance should, of course, be made. Furthermore, an additional correction must be applied in places where the daylight-saving plan is in effect.

Generally it will be found advisable to solve a given problem for at least two sets of conditions, that of the longest day of the year (June 21, declination, 23½° N.) and the average day of the year (March 21 and September 23, declination, 0°).

In the example above, it will be noted that the duration of total afternoon shade is 4 hr. and 34 min. and is considerably greater than the duration of morning shade, which is only 2 hr. and 40

min. This is due to facing the lighting area slightly (9° 8′) toward the east, and suggests quite a range of possibilities as regards orientation.

By applying the principles of descriptive geometry, the amount and location of direct sunlight at any given time may be obtained, if desired, by finding the lines in which the solar rays through the top and bottom limits of the lighting area intersect the working plane—the direction of these rays being taken from altitude and azimuth tables. It may also in this case be necessary to include the effect of side walls, division walls, etc.

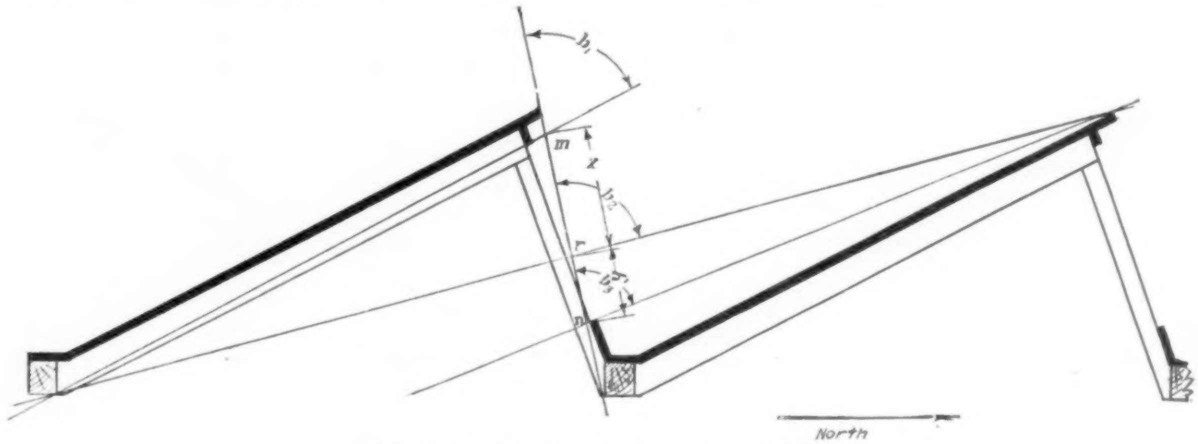

FIG. 2 AREA OF DIRECT SKYLIGHT ADMISSION

For convenience, Table 1 is appended, giving different values of x for assumed values of h as applied in the second method of the example given above. Its use makes unnecessary any reference to trigonometrical tables, unless closer results are desired, for angles not given.

PART 2 THE RELATIVE INTENSITY OF DAYLIGHT RECEIVED FROM THE NORTHERN SKY AS INFLUENCED BY THE SIZE AND SLOPE OF THE SAWTOOTH LIGHTING AREA

It doubtless has been noted that, by essence, Part 1 lends itself to exact mathematical solution. This is not the case, however, with Part 2, for which, as will be explained later, the answer is not to be found so precisely on account of the necessity of introducing certain more or less arbitrary and variable factors. It should, therefore, be applied only with discrimination and strict regard for its practical limitations.

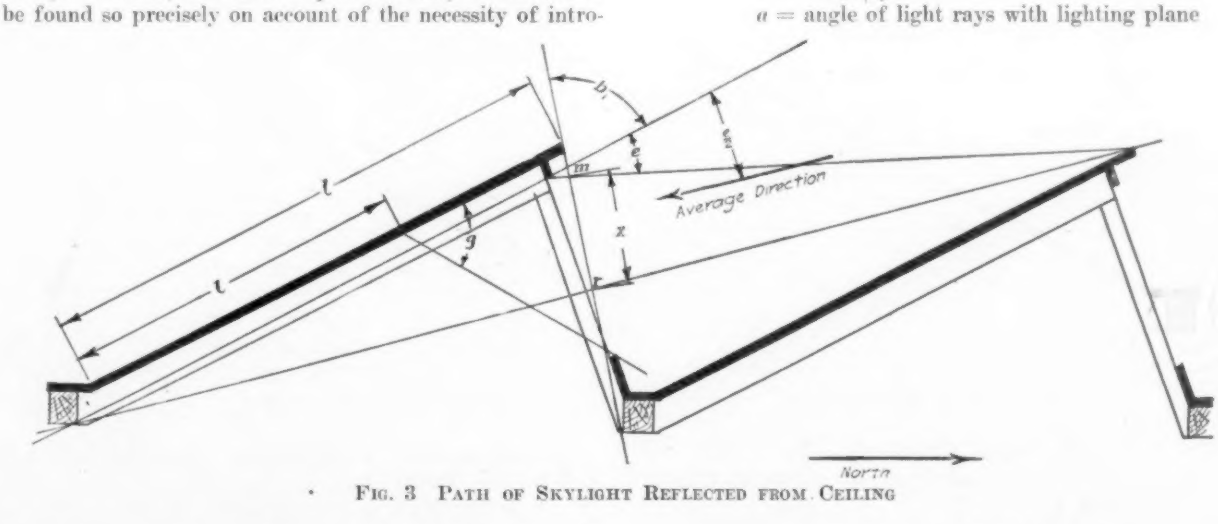

FIG. 3 PATH OF SKYLIGHT REFLECTED FROM CEILING

The total amount of diffused daylight entering a building through sawtooth sash and made available for use (direct sunlight being excluded) may be analyzed as consisting of:

d = light from sky *directly* incident upon the working plane

rd = light from sky *directly* incident upon the underside or ceiling of sawtooth roof and thence being diffusely *reflected* to room below (one reflection)

r_1c = *combined* light from *sun and sky,* diffusely reflected from upper outdoor surface of adjacent sawtooth roof directly to room below (*one* reflection)

r_2c = *combined* light from *sun and sky,* diffusely reflected from the upper outdoor surface of the adjacent sawtooth roof, to underside or ceiling of sawtooth in question and thence being again diffusely reflected to room below (two reflections).

The total amount of light entering the building and due to the summation of the above four elemental quantities is therefore

$$L = d + rd + r_1c + r_2c \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

The author has derived the following approximate formulæ for determining each one of the quantities in Formula [2]:

$$d \text{ (per sq. ft. of } F) = \frac{aS_{x+y} \cdot \frac{180}{\pi} \cdot \frac{\text{vers } a}{a}}{F} \ldots\ldots\ldots [3]$$

where S_{x+y} = area of opening in lighting-area plane as defined in Part 1

F = floor area in sq. ft. over which light from area S_{x+y} is effective, that is, one bay long and a properly chosen assumed width selected for S_{x+y}

a = angle of light rays with lighting plane

$$= \frac{x\frac{b_1+b_2}{2} + y\frac{b_1+b_2}{2}}{x+y}$$

as will become evident by inspection of Fig. 2;

$$rd \text{ (per sq. ft. of } F) = \frac{R_1'D\frac{e}{2}S_x \sin\left(b_1 + \frac{e}{2}\right)}{F} \ldots\ldots\ldots [4]$$

[1] A full account of the trigonometric derivation of these formulæ is given in the complete paper.

where R_1 = coefficient of reflection of ceiling

D = proportion of reflected light utilized to total, which may be taken as

$$\frac{180^\circ - g^\circ}{180^\circ} \text{ (see Fig. 3)}$$

e = sky angle, Fig. 3

$b_1 + \frac{e}{2}$ = average direction of light rays;

$$r_1c = KS_1R_2P_1\left(d + \frac{rd}{R_1D}\right) \ldots\ldots\ldots\ldots\ldots [5]$$

representing average shade line on average day of year

P_2 = proportion of reflected light included between any vertical angle α, Fig. 5, from any point P

$$= \frac{\theta_2 + \theta_1}{2\pi} - \frac{\sin(\theta_2 + \theta_1)\sin(\theta_2 - \theta_1)}{2\pi(\theta_2 - \theta_1)}$$

and the other letters have the same meanings as in the preceding formulæ.

It will be observed that no reference is made to any particular standard unit of flux or intensity of illumination, and the formulæ

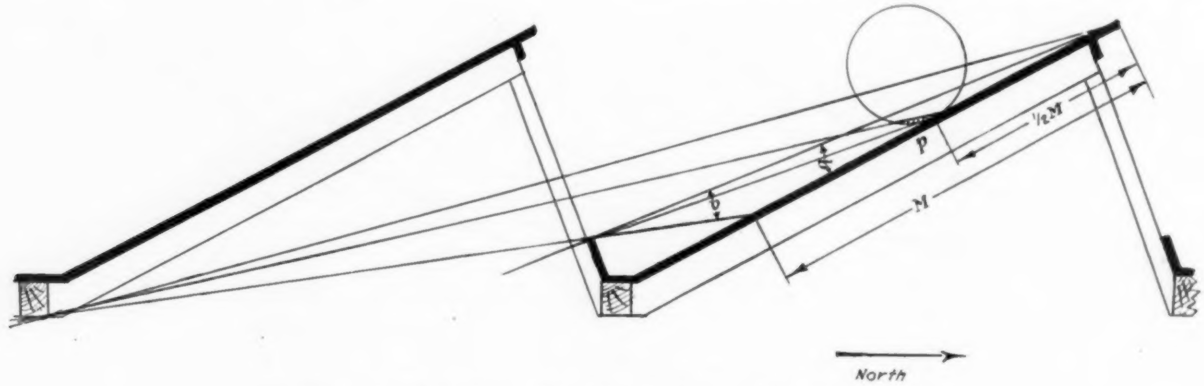

FIG. 4 SUNLIGHT AND SKYLIGHT REFLECTED FROM ROOF TOP

where K = average ratio of quantity of direct sunlight and skylight incident upon one square foot of roof surface as compared with the quantity of skylight only incident upon and passing one square foot of lighting area S_{x+y}

S_1 = ratio of effective roof area to lighting area S_{x+y}

R_2 = coefficient of reflection of roofing material

P_1 = amount of light obtained by reflection from roof, its proportional value included within any

give only the relative or comparative amounts of light furnished under their several respective headings.

The following example illustrates the method of applying these formulæ.

A Numerical Example, Diffused Daylight Conditions

Given the same typical sawtooth roof as in the example in Part 1, having angle of glass = 73°. *Required* to find the total amount of daylight entering, that is, quantity L, Equation [2].

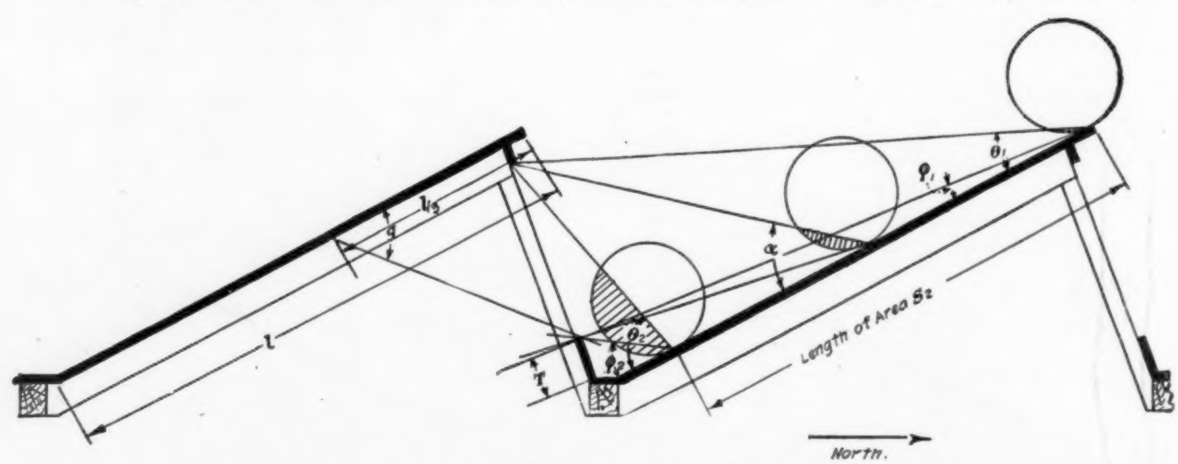

FIG. 5 ENTRANCE OF SUNLIGHT AND SKYLIGHT BY DOUBLE REFLECTION

vertical angle g from any point P being represented by shaded portion of tangent circle in Fig. 4

$$= \frac{g}{\pi} - \frac{\sin 2g}{2\pi}, \text{ approximately;}$$

$d + \frac{rd}{R_1D}$ = quantity of direct sunlight incident upon and passing area S_{x+y} as determined by [3] and [4];

$$r_2c \text{ (per sq. ft. of } F) = KS_2R_1R_2P_2D\left(d + \frac{rd}{R_1D}\right) \ldots\ldots [6]$$

where S_2 = ratio of effective roof area to light intensity computed for roof area included between sawtooth ridge and a horizontal line part way down roof

To find quantity d, Equation [3]. From the detailed building sections, it is found that

$$b_1 = 72^\circ\ 30'; \ b_2 = 86^\circ; \ b_3 = 80^\circ; \ x = 44''; \ y = 22'';$$

whence

$$a = \frac{44\dfrac{72.5 + 86}{2} + 22\dfrac{86 + 80}{2}}{66} = 86^\circ\ 30'$$

and

$$\frac{180}{\pi} \cdot \frac{\text{vers } a}{a} = \frac{180\,(1 - 0.165)}{80.5\pi} = 0.592$$

Let the computations be based on a section of the sawtooth having a length equal to the width of one sash, i.e., 8′ 3″, the latter

having a net width of glass equal to 7′ 3″. The length of span between valleys is 17′ 0″. From the foregoing,

$S_{x+y} = 7.25 \times 5.5 = 39.9$ sq. ft. and $F = 17 \times 8.25 = 140$ sq. ft.

Therefore entering Equation [3],

$$d = \frac{80.5 \times 39.9 \times 0.592}{140} = 13.6$$

TABLE 1 SHOWING VALUES OF (x) IN TERMS OF (h) AND (v)

$h°$	x for v = 70°	x for v = 75°	x for v = 78°	x for v = 80°
3	8° 11′	11° 03′	13° 50′	16° 30′
5	13° 28′	17° 59′	22° 18′	26° 16′
7	18° 29′	24° 28′	29° 52′	34° 36′
10	25° 30′	32° 57′	39° 24′	44° 32′
15	35° 28′	44° 01′	50° 40′	55° 44′
20	43° 15′	51° 55′	61° 05′	62° 43′
25	49° 15′	57° 36′	63° 20′	67° 22′
30	53° 59′	61° 49′	66° 59′	70° 34′
35	57° 36′	64° 58′	69° 41′	72° 56′
40	60° 30′	67° 22′	71° 42′	74° 40′
50	64° 36′	70° 43′	74° 30′	77° 03′
60	67° 15′	72° 48′	76° 12′	78° 30′
70	68° 49′	74° 05′	77° 18′	79° 22′
80	69° 44′	74° 47′	77° 50′	79° 52′
90	70° 0′	75° 0′	78° 0′	80° 0′

To find quantity rd, Equation [4]. From the detailed building sections, it is found as before that $b_1 = 72° 30′$; $x = 44″$; $e = 25° 30′$; $g = 40°$. Basing the computation on the same length of sawtooth as before,

$S_x = 7.25 \times 3.66 = 26.5$ sq. ft.

$F = 140$ sq. ft.

also,

$$D = \frac{180 - 55}{180} = 0.7.$$

Assume that ceiling of sawtooth roof is painted white and has a coefficient of reflection $R_1 = 0.60$. Then, entering Equation [4],

$$rd = \frac{0.6 \times 0.7 \times 12.75 \times 26.5 \times \sin (72° 30′ + 12° 45′)}{140} = 1$$

which is relatively small compared with d.

To find quantity r_1c, Equation [5]. From the detailed building sections, it is found that $q = 15°$

$$= 0.26 \text{ radians, whence } P_1 = \frac{0.262}{\pi} - \frac{\sin 30°}{2\pi} = 0.004.$$

According to a publication entitled *The Sun*, by Charles G. Abbott, S.M., Director Smithsonian Astrophysical Observatory, the average intensity of sunlight plus skylight on this sawtooth roof may be deduced as being during working hours, and for ordinary atmospheric conditions, four times that of skylight on the lighting-area plane. Therefore, let $K = 4$.

S_1 from the detailed sections is found to be 2.3. Assume the roof to be covered with clean white slag having a coefficient of reflection = 0.5. Therefore, entering Equation [5],

$$r_1c = 4 \times 2.3 \times 0.5 \times 0.004 \left(13.6 + \frac{1}{0.6 \times 0.7}\right) = 0.3.$$

This quantity, represented by Equation 5, is usually so small that it may be omitted entirely from the computations.

To find quantity r_2c, Equation [6]. From the detailed building sections, it is found that

$\theta_2 = 80° = 1.4$ radians

$\theta_1 = 24° = 0.42$ radian

whence

$\theta_2 + \theta_1 = 1.82$ radians, and $\sin (\theta_2 + \theta_1) = 0.97$

$\theta_2 - \theta_1 = 0.98$ radian, and $\sin (\theta_2 - \theta_1) = 0.829$.

Therefore,

$$P_2 = \frac{1.82}{2\pi} - \frac{0.97 \times 0.829}{2\pi \times 0.98} = 0.16.$$

S_2 is found to equal in this case 2.7.

$K = 4$, $R_1 = 0.6$, $R_2 = 0.5$, and $D = 0.7$, as before. Therefore, entering Equation [6],

$$r_2c = 4 \times 2.7 \times 0.6 \times 0.5 \times 0.16 \times 0.7 \left(13.6 + \frac{1}{0.6 \times 0.7}\right) = 5.8$$

Whence, Equation [2]

$$L = 13.6 + 1.0 + 0.3 + 5.8 = 20.7$$

This total quantity may be compared with a corresponding value computed for a sawtooth building already in service and of known degree of excellence as regards intensity of natural illumination.

In case additional illumination is required an alternate design having increased glass area or a flatter slope, or both, might be considered and in this connection it is interesting to note that if the pitch is decreased by only 10°, the glass area remaining the same, L figures out to be increased by about 15 per cent. On the other hand, assuming the building placed as in the first example and applying the principles of Part 2, it is found that considerable sunlight will enter for the entire day. That is, the period of total shade would be decreased on June 10 from more than 7 hr. to zero, direct sunlight being present continuously.

This information, when extended to comprehend that for other days of the year, including the day of average length, and when used in conjunction with the particular conditions and requirements of the problem in question (not excluding first cost), should facilitate the selection of the most advantageous design.

Various means have been adopted to exclude direct sunlight from the interior of such buildings, and all of them seem to have the disadvantage of reducing the total illumination. Sawtooth buildings with glass vertical, that is, with the effective angle of the lighting area actually *overhanging* are not uncommon; whitewashing the glass results in some protection against direct solar rays and a cooler interior, but also in glare and considerable loss of light.

Whatever glass is used, cleanliness is essential; furthermore the significance of Equation [6], indicating the possible average relative amount of reflected light, emphasizes the importance of adopting where practicable, light-colored roofing materials such as white slag, and also the use of white dust-resisting washable paints upon sawtooth ceilings of buildings in which maximum daylight is desired. If either of the above surfaces had been black, the average reduction in daylight for the second example would have been equivalent to 30 per cent, or, expressing it another way, the increased light resulting from their use amounts to over 40 per cent.

As before noted, Part 2 of the paper should be applied only with due regard to its practical limitations. It furnishes a means of comparison with known designs and is based on fair-weather conditions and with sunlight on the building as a whole. During cloudy weather the amount of useful light contributed from the top of the sawtooth roof is, of course, decreased, but, on the other hand, the quantity of direct skylight, which has been found to constitute the major portion of the total, is often thereby considerably increased.

Conclusions

From the foregoing analyses it is evident that the height of valley (T, Fig. 5) for a given construction should be made as low as is consistent with protection against the elements, including snow and ice.

Furthermore, it will be seen that for a given building the use of a *small* number of *large*-scale sawteeth as against a greater number of *smaller* units having the same pitch, results in considerably increased daylight due to fewer number of valleys of height T, and consequently less proportionate obstruction. This principle, of course, should be applied with due regard to the structural limitations and the architectural considerations which may be involved, together with the important question of uniformity of daylight intensity.

It is also worthy of note that the adoption (for the reasons above outlined) of flatter sawteeth with increasing terrestrial latitudes works out well in conjunction with the heating requirements, since it results in less cubage and radiating surface.

EMPLOYMENT OF LABOR

By DUDLEY R. KENNEDY,[1] PHILADELPHIA, PA.

MUCH concerning the description of the engineering and construction of the Hog Island Shipyard has appeared in various trade and technical journals. The labor requirements of the undertaking and the different phases of the activities undertaken in connection with the problem of securing employees and providing for their needs and comfort are explained in this article.

The contract between the United States Shipping Board and the American International Shipbuilding Corporation, Emergency Fleet Corporation, signed on September 13, 1917, called for the construction of the largest shipyard in the world and 120 ships, to be built therein, all in twenty-one months. Seventy of the boats were to be cargo carriers of 7,500 dead-weight tons and 50 boats of 8,000 dead-weight tons, combination cargo and transport.

The yard was to have 50 shipways, or two more than the six largest yards in America combined, with the necessary administration and service facilities to properly serve this number of ways.

The construction of the yard was practically complete on October 20, 1918. The following figures give an idea of what has been accomplished:

18 miles of streets and roads
82 miles of standard gage ballasted railroad track
21 miles of water pipe
50 shipways requiring the major portion of the 127,000 piles driven
72,500 ft. of drainage ditches
71,350 ft. of sewage piping
90,000 ft. of compressed-air pipe for the second largest compressed-air plant in the world, the largest being at the Rand Mine in South Africa
16,300 ft. of fuel-oil pipe
A water-supply plant from which the plant is now using daily 2,000,000 gallons of water
250 buildings
15 large restaurants and cafeterias, serving daily 12,000 to 18,000 meals
4 ships have been launched
44 are under construction
61,000 tons of steel have been placed in ships
7,000,000 rivets have been driven
The bulk of 3,500,000 cu. yd. of material to be dredged has been removed and all of the divers and sundry things incidental and necessary to all this, which can be readily left to the imagination of a group of engineers familiar with such general problems.

All this has required the expenditure of much money. To illustrate more graphically just how much, and with what speed the job has progressed, it may be added, that the rate of money expenditures has been five times that of the Panama Canal.

In the inception of the job when the engineering estimates were in preparation, it was recognized that the labor problem would be one of the cardinal difficulties of the undertaking. Notwithstanding the difficulties, there were upon the payroll on January 19, 1918, 26,700 men, and there are now 35,000 employees. To obtain this number and maintain the necessary interim quota it has been necessary to hire a few more than 230,000 people in a calendar year. This means a labor turnover of nearly 700 per cent.

Let us see what conditions were when the job was started. Hog Island is situated about eight miles south of Philadelphia City Hall, upon the Delaware River, in a comparatively isolated spot, known principally for its shooting and its mosquitoes, inaccessible as far as regular transportation facilities were concerned.

At first, there was no passenger transportation into Hog Island by rail and how the employees traveled to and from Philadelphia is and will always remain largely a mystery.

Today there are two trolley lines, a steam shuttle line connecting with the main line of the Pennsylvania and the Reading, and an excellent train service over a special cut-off line of the Pennsylvania.

In the inception of the job, the management, appreciating the size of the "Human Engineering" phase, organized a department styled the Industrial Relations Department, having jurisdiction of the branches Employment, Medicine, Surgery, Sanitation, Safety, Housing, Feeding, General Welfare and Service and Compensation. Each of these will be described separately.

Employment Department

The manager of Industrial Relations ranks, with equal authority, with six other heads of departments, reporting direct to the President. This is an important point, as many companies now appreciate the importance of the "Human Machine" to a degree which places an executive in charge of Industrial Relations with authority paralleling that of executives in charge of other major phases of administration. This department occupies a two-story building 251 ft. long by 48 ft. wide, with an ell 132 ft. long by 63 ft. wide.

The Employment Department occupies the bulk of the first floor. The waiting room is 85 ft. by 48 ft. and will accommodate 800 men. The building was planned to afford as nearly a stream line or continuous process as possible through the various stages of the necessary employment routine; therefore the waiting room is situated at one end of the long face of the building. Immediately the applicant for employment finds for himself a place in one of six lines, formed before six doors, over each of which appears the name of the positions or jobs for which men are being examined in that "interviewing room."

In each of these six rooms is a man familiar with the specifications of the job or jobs for which he is selecting applicants, and into his room he receives in turn the men in line, and to each he gives a short, courteous, but adequate and firm catechising and determines his fitness for the position which he seeks.

Having accepted the applicant, he passes him on to the registration clerks, of whom there are about 25, who fill out a registration blank covering the many details which it is necessary to record for purposes of identification, for the State Workmen's Compensation Law, for the Selective Draft and for statistical purposes. This form when completed is handed the man and he proceeds to the physical examination, where he enters one of thirty booths and receives an examination in the nude to determine his fitness for work and for the particular job to which he is assigned.

Successfully passing this examination, the applicant proceeds to the photographic room, where he is photographed *with* his sequential employment number, which becomes his identification and payroll number, and his height and weight and date of hiring. This information is placed in a rack by lettered and numbered cards, and the new employee stands with his chin just over the rack so that the printed photograph shows all this information. This business of plant protection and identification has been perfected to such a nicety as to make possible the taking, developing and printing of 4000 of these pictures a day.

The new man is then taken to the Dispatcher and there the new men are grouped and taken by one of 15 messengers to the portion of the work for which they have been hired. When the messenger delivers a new employee to a department, the requisition issued the day previous is canceled, and the foreman signs a receipt discharging the obligation of the Employment Department.

The messenger is made necessary for several reasons, but principally because the plant covers 900 acres, has eighteen miles of streets and is 2½ miles long and a mile wide, and it is quite a task for a newcomer to find his way about.

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Medical Department

The Chief Surgeon is responsible for the medical, surgical, and sanitation divisions. The hospital equipment is the most up-to-date procurable and the hospital contains an anesthetic room, operating room, X-ray room, first-aid dressing room, re-dressing room, two wards containing 21 beds, dental clinic, eye clinic, heat-treatment room, etc.

In the month of August 1918 the plant had 7583 accidents, of which, however, only 160 were time-losing accidents of over one day. The percentage of accidents was only 0.97 per cent of the men employed, or less than 1 per cent, and the infections ran 1/8 of 1 per cent, all of which compares favorably with the best records shown by the largest commercial companies in the country.

Sanitation

Hog Island has all the problems of sanitation and hygiene of any city of 35,000. Working under plans of this Department, the mosquito has been absolutely eradicated and with it vermin of all kinds. The Department maintains a chemical and bacteriological laboratory which tests the drinking-water supply at all points of egress daily, analyzes sewerage, samples and tests all food served, and does all the work of the hospital on sputum, pus, excretions, blood, urine, etc. The Department maintains the medical dispensary, contagious hospital, and detention barracks, and its alertness and efficiency have made possible the phenomenal record of last winter as to the general health of workers, resident on the Island, and the record of the present influenza epidemic. For both, Hog Island records were as good as any shown by army cantonments.

Safety Department

The Safety Department is modeled along lines in general use by the larger corporations and the figures before quoted on accidents show that it has done its work well in so quickly bringing a "mushroom job" to the standards of the old-established corporations.

Housing Department

The Housing Department task has been trying, but barracks have been completed on the Island for 5000 employees, a bachelor hotel has just been opened accommodating 2200 men, with 2200 rooms. It is in fact the largest hotel in the world today. The E. F. C. has finished and is completing a unit of 953 homes of brick construction for married employees of Hog Island which rent for an average monthly rental of $25 for six rooms and bath.

During the last year the Housing Department has furnished 16,500 accommodations in the city of Philadelphia, and this in the face of the Philadelphia Housing Association's statement of a year ago that the city possessed not more than 5000 accommodations for the incoming human flood.

Feeding Employees

The Commissary Department is one of the most interesting on the Island. Its employees number 700, in 27 different units, the largest of which accommodates 3000 at a meal, and it feeds an average of 17,500 persons per day and during August of this year served 486,964 meals. The Department is run by the company for its employees without profit. Straight meals sell for 30 cents each, while the average cafeteria meal receipts are about 33 cents.

Service and General Welfare

The Service Department handles the matters most readily understood as welfare. These include the plant industrial Y. M. C. A., athletics, the plant weekly paper, and general services and welfare.

The welfare of the women employees is in the hands of a woman physician who fills the joint capacity of Welfare Director and Medical Advisor for them.

There are now employed over 2500 women. Most of these are in the offices in various capacities, and in the commissary department, but the employment of women for yard work has long since passed the experimental stage and women are working in our yards at 20 different tasks—from common labor to such skilled tasks as acetylene cutters and welders, and their number is being constantly augmented as the prejudices are being broken down and as the man-power shortage grows more acute.

Workmen's Compensation

The Workmen's Compensation for employees is administered by a branch of the Industrial Relations Department under the terms of the Pennsylvania Act.

The wage setting and adjustment for the job has been a serious task, and while the U. S. Shipping Board Labor Adjustment Board has fixed a standard scale for all shipyards, covering the shipbuilding trades, the construction of Hog Island presented many problems on construction rates involving almost every conceivable craft. Notwithstanding the hardships to which workmen have been subjected, and the difficulties with which the works has been beset, not one day has been lost through strike or labor difficulty. The "open shop" has maintained throughout and it is only justice to say here that organized labor has, in the main, lived up to its agreement with the Government in not attempting to force recognition or the "closed" shop.

Almost the universal problem with employers has been the question of securing a sufficient number of employees to operate at maximum capacity. It has been a question of "collection," not of "selection."

INDUSTRIAL ORGANIZATION AS IT AFFECTS EXECUTIVES AND WORKERS

By CHARLES E. KNOEPPEL,[1] NEW YORK, N. Y.

THE object of this paper is to establish some rules of efficient organization for the practical guidance of executives in developing an intelligent system of industrial relationship. Now more than ever, after so many years of war, it is required to direct every effort to increasing industrial production and promoting international trade, in order to coöperate in the tremendous task involved in reconstructing the world.

Three facts must be borne in mind in connection with the problem of industrial relationship: Industry is nothing but the collective action of various individuals; management consists of controlling and guiding the acts of the different agents engaged in industry; and industrial relations are the reactions created in all individuals, as a result of this control or guidance on the part of the management.

The flow of influence in relationship is from the administrative executives to the operating heads, to the superintendents, and finally to the workmen. In order for this influence to operate successfully there must exist a system of proper coördination

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among the various agencies in industry. Well-defined policies in the executive branch of an administration secure contentment and satisfaction in the workers.

The following suggestions are offered in an effort to formulate a code of practical laws of efficient organization:

The Objective

A tentative plan of organization should be worked out and decided upon. Owing to the presence of unknown factors, which cannot be determined in advance, the ultimate objective cannot be agreed upon at the outset; in fact, it will be well toward the completion of the work before the final type of organization can be settled upon. No plan can be worked from the top down in its entirety, nor should one be worked altogether from the bottom up, for this would result in a development lacking coördination. The game should be one of " playing the ends against the middle."

Greatest Complication

A department should be divided into the most difficult functions which the men in charge will be called upon to undertake. The evolution of industry from a one-man stage to that in which many men are needed for the handling of specific things, has been based, consciously or otherwise, on this " law of greatest complication." In manufacturing, for instance, there was no doubt a time when the same man could both design and sell what was to be made and then go out in the shop and make it. But as the knowledge required of a man to design, sell, and to make, became greater and more complete and intricate, it became necessary to form two sections or departments, each of which took over one of the functions named above. Each department was placed in charge of a specialist, and both departments were supervised by the man who formerly handled all the details himself.

This law that is involved applies not only with reference to a business as a whole, or to a single department of a business, but to any division of any department.

There are several reasons for establishing this law: First, to guard against putting more work on the shoulders of a man than he has the knowledge and ability to handle; second, to make it possible to pick out the hardest job first; to make possible the selection of that work which will yield the greatest returns in the shortest possible time.

Concentration

Each section, division, or department of a business should be so arranged as to contain all the factors which will effect the performance of only its own function. If such a plan is adopted, the head of the work can be held strictly responsible for the successful conduct of his department, as he controls all the factors in connection therewith and can therefore be given to understand that he will stand or fall according to his showing.

The strict observance of this law when organization is being effected greatly reduces the amount of supervision required, and also tends to develop and strengthen the men in the concern. If a man is given full charge of a division or section of a business, and controls every factor that affects the successful performance of the main function of that division or section, he can be held wholly responsible for that function. If, however, other men besides himself have charge of some of the factors affecting the success of that function, it is impossible to hold him solely responsible for it. The only method of supervising him, under such circumstances, will be to hold him responsible for all the operations in his charge that affect the performance of his function, and then to check him up carefully. Such a system involves an excessive amount of work in supervising, and also forces the man himself to follow personally all the details of the work he supervises, in order that, when called to account for them, he may be familiar with their condition. Any one, under such a handicap, will naturally become absorbed in details, to the detriment of his executive work.

Individualism

A battle cannot be won by half a dozen generals, all of whom have equal authority. There must be one-man control.

There is nothing more confusing in an organization than for employees to have more than one man to whom they are directly responsible, and nothing that so quickly destroys discipline as to have a manager go over the heads of his subordinates. Yet these are among the faults we find most frequently in organization work.

When a man enters an organization, his duties and all matters which he is to be held responsible for should be definitely stated to him. In addition, he should be told who the head is to whom he is responsible for carrying out his duties, as well as who the men are that will be responsible to him.

Mutual Capacity

When a department or business is reorganized, a division should be made with reference to the knowledge and ability that will be required of the man who shall supervise the work, as well as with respect to the knowledge and ability that those men must have who shall actually carry out the work. Then, too, what is to be done must be within the capacity of the average types of men who are fitted to fill the various positions.

If an organization is divided according to its most difficult function so that the knowledge required for each position will be as little as possible, and the positions are arranged so that each executive has complete control of all the factors affecting the success of his function, the executive jobs, as a rule, can be well handled by average men. If, however, the organization is incorrectely divided, and each executive is given a slice of this and a part of that, and the success of each man's job is dependent on the successful handling of a lot of work that is handled by other executives, then there will be great difficulty in obtaining executives who can produce satisfactory results. Even if the company, under such circumstances, does hire executives of proved ability, they will soon deteriorate under the bad form of organization, will lose all their initiative, and will become worthless in a few years.

Specialization

An organization should be divided so as to develop specialists. To this end, care must be taken that one department head shall not duplicate the work of another.

Specialists are developed by allowing men to work in a limited field of knowledge. In other words, a man is so developed that instead of knowing many things superficially, he will know a few things extremely well. If the knowledge necessary to manufacture and market a number of products is divided up into a number of limited fields of knowledge, as it were, and one man is put in charge of all the work in each of these fields of knowledge, these men will become specialists. Now if, under each of these men, each of the sub-heads is in charge of all the work representing one portion of that field of knowledge, then there is an organization of specialists.

In an organization of specialists there is no difficulty in finding men to fill competently executive positions, for the average man with executive ability can handle efficiently a large amount of work in a limited field of knowledge.

Responsibility

An executive should be held responsible for the total proven results, or for inability to secure results, and not for the details of the methods that he uses in trying to secure these results.

It is a frequent fault in organizations that the bigger executives —especially those who, when the concern was small, followed all details—judge the executives under them by various details that they find wrong, instead of judging them by the total proved results in that section of the business for which those minor executives are directly responsible.

Permanency

What would happen if, during an engagement, a member of an artillery squad, or of a gun crew on a battleship, should suddenly be killed, and none of the others should know what to do in his place? The consequences would be serious indeed. And yet in industry we find many cases in which no provision has been made for training men to fill the positions of their superiors, in case anything should happen to the latter. A man may at any time be transferred, or he may die, or be taken sick, or resign his position, or take a vacation, or be dismissed from the employ of the company. In any of these cases, it will be the duty of some one else to fill the gap at least temporarily, perhaps permanently, and if no one has been trained to take over the new work, results are bound to be unsatisfactory, if not disastrous.

Relationship

A business is nothing more or less than the adjustment of individuals, to the end that all may follow a definite policy, or line of procedure. One of the weaknesses in business is the almost universal practice of giving an individual only the most general kind of instructions concerning what to do and how to do it.

A man is engaged to do a definite "something," and just what that something is should be known by all with whom he comes in contact; otherwise he cannot be held responsible for results. His functions in the business, his duties in performing this function, and his relation to others and of others to him, should be sufficiently defined so as to enable him to work efficiently.

Personnel

A set of specifications covering the qualifications required in each of the members of the personnel should be determined before making their selection. Hiring men is, or should be, like purchasing materials, in that there should be, first of all, definite knowledge of what is required. After all, it is a case of matching qualifications against requirements. If we know what we want, we can check the merits of the material that we examine. For instance, if a position demands close application, long hours, and indoor work, it is sheer folly to engage a man who loves the open and therefore detests confinement and close application. He would naturally be inefficient because discontented and unhappy.

If it is essential in buying a machine, to lay down certain specifications, and then make sure that the machine measures up to them, it is just as important to have specifications in regard to the men we shall engage, in order that we may check their qualifications against them.

Instructions

A ship without a compass would not be used in ocean transportation; a boiler without a safety valve would not be used in a steam plant. And yet in industry there is little, in many plants, that corresponds to compass and safety valve; or, in industrial terms, there is a lack of instructions and charts.

Anything worth defining is certainly worth recording and yet we have all seen organizations of people working together without any guide whatever in the form of standard practice, no definite idea of functions and duties, no charts showing relationship. The difference between having such charts and not having them is simply the difference between organization and disorganization.

The concern that insists on properly issuing complete written information covering the material it buys or the product it sells, will deem it unnecessary to have written instructions and charts covering the operations of the people who use the material and make the product.

Staff

The chief of staff should be a man of experience, tact, and exceptional analytical ability. Every department manager should have the right to call on the staff to assist him in the solution of his problems, and to have them make detailed studies of any sections of his department that are not running satisfactorily. If the managers can be induced to make such calls on the staff freely, the results obtained will be satisfactory, but if staff advice has to be forced on them the results will be poor. Staff consultation should never be forced on a manager except when the reports from his department show decidedly poor results and he does not call on the staff for assistance. In these cases it should be suggested that the staff assist him, and if he refuses to take the suggestion, he should be forced to accept their coöperation.

Functions of an Executive

The functions of an executive should be: To exercise general supervision over the business or the department; to analyze results critically; to put new problems before his men for their consideration, advice and action; to criticize subordinates when results are not forthcoming, explaining the reason why; to see that the prescribed practice is regularly followed.

An executive should not attempt to do everything himself, but should deputize authority among competent assistants. He should not waste time over minor details, and, most important of all, he should study men in order that he may be able to arouse in them the greatest possible amount of initiative.

If the solution of the present economical problems is ultimately dependent on the successful development of industry, and this can be achieved only by efficient organization, it is the duty of every industrial community to take the steps necessary for securing an undisturbable harmony between its various social elements. By the coöperation of capital and labor, with a perfect understanding between the employer and the employee guided by a sense of justice and fair dealing, industry will contribute mightily to the progress of the world.

LABOR DILUTION AS A NATIONAL NECESSITY

By FREDERICK A. WALDRON,[1] NEW YORK, N. Y.

THE term "Labor Dilution" originated in England shortly after the declaration of war with Germany. Its original application was intended to carry out in effect what the definition of the word "dilution" literally implied; namely, a thinning or spreading out. As applied to labor, it means the thinning out or spreading of the functions of the skilled workmen among those that are less skilled, and a Bureau of Labor Dilution was therefore established by the Government to supervise and carry out its requirements.

The original objective of this bureau was to relieve the skilled workman in the performance of certain functions of a task and employ less skilled workers for the purpose of accomplishing a given task in a shorter time.

The development of the work of this bureau has been such that economies heretofore unknown have been established and the fact brought before the manufacturer in evidence strong and beyond contradiction that many things done for apparent necessity were not at all necessary to the proper and efficient conduct of busi-

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ness. Its work, during the war period, will become a national industrial asset and change the entire mental attitude of the employer and the employee to one of greater coöperation and higher efficiency for years to come.

Unintentionally, perhaps, and unconsciously this bureau has created an element in labor dilution which was not included in the original program, as it has already established in the minds of the consumer that waste of labor and materials is the greatest foe to labor dilution that a nation may have.

This is a vital problem, and it is the engineer who must solve it in a scientific and satisfactory manner. For years following the war our work must be done in the spirit of conservation, with profits a secondary consideration. This involves the engineering of men in the broadest sense, since the supplies of both have become so seriously depleted through the waste of war.

Ultimately it will be the "survival of the fittest." A nation's industries must be those for which it is particularly adapted; they must be conducted in the most economical manner, and facilities for vending and transporting their products must be on an equally economical basis. For products of equal quality, those having the lowest unit costs will naturally maintain commercial and industrial supremacy. The nation which can deliver to the consumer its converted natural resources in the minimum of time with the least expenditure of human energy is the nation which will lead the industry and commerce of the world.

To accomplish this there must be a broad and comprehensive national policy in the organization of our legislative, banking, business, agricultural, transportation, mining and manufacturing policies.

As the value does not appear until labor has been applied to nature's labyrinth of wealth, it is incumbent that the study of labor requirements and performance be given most careful consideration, and to this end it will be helpful to summarize the conditions which confront us at the present time, as follows:

1 The equipment and physical condition of our transportation facilities are not being kept up to the pre-war condition of efficiency
2 Agricultural industries are suffering for the lack of labor and intensified productivity of soil
3 Our roads and highways are rapidly deteriorating due to the lack of man power to construct new and repair the old roads
4 Work on the enlargement and development of public utilities is practically at a standstill
5 Irrigation projects are practically stopped
6 The manufacture of munitions, when abandoned, will place an immense amount of machinery in the scrap heap. This must be replaced by new machinery
7 Operations in the erection of buildings other than those required for immediate war needs has practically ceased
8 The output of our steel mills has been practically absorbed by the Government for war work
9 Immigration has practically ceased
10 The birth rate will supply but a small percentage of the man power needed.

From the enumeration of the above items, it can be fully appreciated that the accumulation of work to be performed is stupendous. Therefore, if our present methods continue, the great problem will be to obtain labor for this work.

It is self-evident that we cannot depend on European immigration to this country for this period. The depletion of man power due to war losses and the demand for this power in the reconstruction period abroad, combined with the internal development that is likely to take place in Russia, will mean that immigration from these countries will be prohibited. Further, of the man power sent by this country to Europe, at least ten per cent will be incapacitated for work of a strictly laboring character.

We will, therefore, be practically dependent upon native-born Americans based on our population of 1900 to 1905, which is estimated as 90 to 95 million. The best available statistics at the present time would indicate that the average birth rate of this country is 25 per thousand population and that the death rate is 15 per thousand, leaving a net gain of ten persons per thousand. This means that there will come to workable age in the post-war period about 900,000 yearly, of whom approximately 400,000 will be males.

While the employment of an abnormal number of females as a war measure is right and justifiable, its continuation during the post-war period is problematical from the standpoint of the nation's man power.

This brings the subject of Labor Dilution as a National Necessity to a phase much broader in its meaning than that which was originally intended.

Broadly speaking, labor dilution should consist not only in the functionalizing of the work of the skilled man with that of the less skilled man, but it is equally important to eliminate useless and unnecessary labor which, at the present time, is deemed necessary due to the mental attitude and the habits formed in years of development and peace. It would seem, therefore, that the problem of labor dilution can best be approached by classifying into the following program:

1 STANDARDIZATION (indirect); (a) Legislative methods, (b) business and financial methods, (c) transportation methods, (d) mining and agricultural methods, (e) manufacturing methods.
2 COÖPERATION (indirect): (a) Legislative methods, (b) capital and labor, (c) engineering methods.
3 ELIMINATION (direct): (a) Non-essential statistical work and data, (b) non-essential office work, (c) non-essential administrative work, (d) non-essential sales and advertising work, (e) the idle citizen or loafer.
4 EDUCATION (direct): (a) Of the legislature, (b) of the business man, (c) of the engineer, (d) of the executives, (e) of the laborer.
5 OCCUPATION (direct): (a) Analysis, (b) distribution, (c) localization, (d) compensation.

STANDARDIZATION (Indirect)

While the final effect of standardization on labor dilution is indirect, this is the foundation on which it should be built. The principal divisions are outlined above and will be briefly analyzed in the order of their importance.

a Legislative Methods. All laws regarding the conduct of business should be simple and direct, and the purpose in view should be the eliminating from the honestly conducted business, complications or hardships involving unnecessary expense and red tape; such laws to be drawn up with the hearty and consistent coöperation of the legislator, the business man and the employee, with the view of making them as simple and direct as possible. With honesty of purpose and fair dealing on the part of all, there should be no serious difficulty in establishing laws that would be much more simple and uniform than those at present in force.

b Business and Financial Methods. Where there has been rapid growth and an immense volume of business, it has necessarily carried with it an enormous labyrinth of complication, duplication and detail work which requires the employment of a large number of non-producers to care for records necessary to bring the raw material to the consumer. The result of standardization would, in a measure, automatically eliminate this labor and tend to reduce the cost of doing business.

c Transportation Methods. The amount of labor involved in the transportation of raw material to the consumer, directly or indirectly, is enormous. By the adoption of standard forms, carriers, and an improvement in the vehicles of transportation, with improved methods of handling materials at the terminals, a great amount of labor would be liberated for other work.

d Mining and Agricultural Methods. The amount of labor employed on this class of work could be greatly reduced by the introduction of new machinery and the perfecting of existing machinery. In mining great progress has been made in the reclaiming of what was once considered waste ore. Certain strides have been made in the agricultural field whereby the productivity per acre of ground has been greatly increased. This practice, however, has not been employed in a large number of the small

areas under cultivation. Intensive mining and farming should be given more attention.

e. Manufacturing Methods. The standardization of production in our factories would eliminate a large amount of surplus materials which are now carried in stock by the dealers, and would allow of interchangeability of parts that are most essential and enable business to be transacted direct with the consumer. This would reduce the inventory investment of manufacturers and dealers, thereby reducing the number of pieces to be made and the labor applied thereon.

Coöperation (Indirect)

It naturally follows that, in order to obtain the benefits from standardization, coöperation should obtain to the fullest extent; and by continuous and systematic effort on the part of the legislator, the business man, the engineer and the workman, the essentials under the head of Standardization would begin to produce results.

Elimination (Direct)

The natural results following standardization and coöperation would be elimination, since many employed at the present time would necessarily be transferred to other lines of occupation.

The general headings covering the classes of work eliminated are included in the preceding classification.

Education (Direct)

Following standardization, coöperation and elimination there should be a concerted effort to educate to a new epoch of economy. The term Education as applied to this particular phase of the situation is used as an expression for the change of the mental attitude of the public from that of extravagance to that of basic economy. It should teach that "waste makes want and want makes woe," and that the conservation of our present energy and natural resources is of greater national value than the unlimited accumulation of the almighty dollar.

Occupation (Direct)

Last but not least, occupation should be considered in the problem of labor dilution. An era is approaching in which the conditions of the present and past will be entirely changed and which will involve a wholesale change in the distribution of occupations.

In order that this may be done with the least disturbance, a careful analysis should be made of the adaptability of the individual to the occupation, and consideration should be given to the distribution of such occupations. Coincident with this should follow the locating of industries at such points as will insure economic production.

The occupational problem that will ensue will always lead to differences of opinion, but it is governed largely by supply and demand and the standards of living in different communities or nations. The lower the standard of living, the lower the compensation for labor. The higher the standard of living, the higher is labor compensated. The problem, however, resolves itself into the production and delivery to the consumer at the lowest possible cost with a fair profit to the manufacturer.

These are facts showing that "a condition and not a theory" confronts us. If it is expected to keep in circulation the currency of the world at the present rate, it is necessary that public improvements, manufactories, agricultural and mining interests should continue at a rate commensurate with the present circulation of money.

This means a gradual readjustment, and, in order to be prepared for this readjustment, the problem should be looked squarely in the face and the way paved by which such readjustment can be made with the least possible disturbance. This can only be done by careful planning and action on the part of the country's greatest men in preparing to meet the problem of labor dilution in a broad way.

The English, with their customary conciseness, have expressed in the two words, "Labor Dilution," that which it would require volumes to describe or discuss.

A study of the problem indicates that, in its broadest meaning, Labor Dilution and the Engineering of Men are practically synonymous, since the former involves all that the latter implies.

USE OF NON-FINANCIAL INCENTIVES IN INDUSTRY

By ROBERT B. WOLF,[1] SAULT STE. MARIE, ONT., CANADA

THE basis of all "non-financial incentives" is interest in work. Interest in work implies a desire to produce, actuated by internal motives rather than external discipline.

Production means creation, and the industrial creative function in man is a mental process and lies in his intelligent adaptation of means to ends. It is useless, therefore, to look for real creative work unless the workman has a chance to think and to plan; any other working environment either fails to attract or actually repels the workman, and as a consequence offers no incentive to increased effort.

Work which does not call for thoughtful reflection and which uses only muscular effort tends to draw men down to the level of the brute and makes for industrial irresponsibility and consequent social disorganization. The unthinking man cannot be a responsible man.

It is the self-conscious faculty of man which distinguishes him from the animal and makes him, above all, a creative center through which the universal life-giving power can deal with a particular situation in time and space.

To use a homely illustration with which every one is familiar, the traffic at each crowded street crossing cannot be regulated from the City Hall; it requires an individual (the traffic policeman) in the congested spot to deal with each particular situation as it arises, and upon his powers of observation and selection depends the orderly flow of traffic.

It is only through the individual life that the universal life can act, and therefore the universal is compelled to evolve many individual lives if organization and order is to replace the unorganized state represented by the purely generic operation of natural law.

The problem of social organization is, then, how to organize society upon the basis of respect for the individual. This is also the industrial problem as well, for industry in the broadest sense is society in its highest form of activity because it is essentially constructive and therefore creative activity.

It was an inevitable corollary to the universal plan of creation that the individual life came into being, not to create material substance as that had to be before individual life could gain consciousness. The function of the individual life, however, is to create by a thought process conditions especially selected to produce results which nature unaided would find herself unable to produce.

This is what the horticulturist does. His power lies in his knowledge of natural law, and his creations are made possible because he conforms to the law. The uncultivated orchard reverts to its original wild state when no longer attended by man, but increases in productiveness by continued thoughtful application of man's power of selection and adaptation.

It is by a similar process of conscious selection that such devices as the steamboat, steam engine, electric generator and the

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telephone came into existence. They did not come into being, and never would have been created by the generic operation of nature's laws.

* * *

The creation of artificial conditions, which, taken all together, we call civilization, is, of course, the product of man's organizing power. While self-consciousness, the power of realizing the self as apart from the rest of the universe, has been a human faculty for untold ages before the present highly organized state of society had been attained, it is nevertheless true that now, for the first time in the history of the white race, we are confronted with the problem of correcting the repressive or selfish character of civilization so that it will serve the mass of humanity. If we fail to accomplish this it will be destroyed by the same creative power which brought it into existence.

We must learn how to change the industrial environment from one which repels mankind to one which attracts. In other words, the incentive to work must be inherent in the nature of the work itself.

Now what are the conditions which we must meet in the industrial world to make work attractive? We have ample evidence that increasing financial returns have failed to stimulate productivity; and, on the other hand, the constant demand for shorter hours and the increasing labor turnover is proof that work in most of our industries not only does not attract, but actually repels, the workman. We must, therefore, look into the working conditions themselves for the answer. This is the only scientific method of procedure.

* * *

It can be shown that creative work can be done to a great extent in modern industry, and that it can be accomplished without radical changes in equipment, greatly to the advantage of both employer and employee. To do this, individual progress records are necessary, so that the workman can know from day to day how he is improving in the mastery of the process.

The first example, illustrated by Fig. 1, is from that branch of the wood-pulp industry known as the sulphite process, and shows a cooking chart which was designed to give the cook information about the reactions in the digesters in which the wood chips are cooked in a 6 per cent solution of sulphurous acid partly combined with a lime base.

The digesters have a conical top and bottom and are usually 50 ft. high by 15 ft. in diameter. After the acid and chips are put into the digester and the cover is put on, steam is turned in at the bottom and the pressure brought up to 75 lb. per sq. in. above atmospheric pressure.

As this does not heat the digester sufficiently to produce disintegration of the wood, it is necessary to relieve gas through a relief valve on the cover. Because of the removal of this gas, which is afterward reclaimed, more steam can come in at the bottom and thus the temperatures are advanced. The skill in cooking consists in the proper control of the relief valve.

Before the introduction of these cooking charts illustrated by Fig. 1, all this was left to the unaided judgment of the cook, with usually nothing to help him but a small hand thermometer and a pressure gage. Of course, great variation in the pulp was the result. The cooking charts, plotted by the cooks themselves, however, helped greatly as they enabled the quick visualization of the work. On these charts temperatures are converted to pressures for the reason that the pressure in the digester comes from two sources, one the natural pressure due to steam, and the other due to the sulphurous acid gas.

* * *

At the end of the cooking process the gage and steam pressures will naturally come very close together, as the greater part of the SO_2 gas has been used. The gas-pressure curve is obtained by subtracting the steam pressure from the gage pressure. It is really a resultant of the other two. If it drops too rapidly the cook knows he is relieving his digester too hard and checks the opening of the relief valve. If it does not drop rapidly enough he knows he must open the valve wider in order to increase the relief. Of course, the figures are taken from recording instruments which are checked daily to insure accuracy. Naturally, an ideal cooking chart was soon formed, being the joint work of the cooks handling the digesters and of the chemical research department.

Immediately after the introduction of these charts a very marked increase in the uniformity of the pulp was noticed, and the cooks, while at first opposed to the new method of "cooking with a lead pencil," as they called it, soon learned to like their work much better for the reason that they now had some way of visualizing the work in its entirety.

In addition to more uniform quality of the pulp, the yield from a cord of wood increased something over 5 per cent.

We soon found that it was necessary to give some sort of continuous progress record if we were to keep up the interest in the work, because no man could carry in his mind anything but a

Hours	Temp	Gage Pressure	Steam Pressure	Gas Pressure
0		0		
1		20		
2		48		
3	212	75	0	75
4	222	75	3	72
5	233	75	7	68
6	240	75	10	65
7	250	75	15	60
8	259	75	20	55
9	273	75	29	46
10	288	75	41	34
11	284	57	38	19
12	281	40	35	5
13				

NAMES OF COOKS AND GENERAL INFORMATION FILLED IN HERE.

ACID TEST {Total 7.00, Free 6.05, Combined 0.95

Acid Temperature 75 Degrees Fahrenheit.

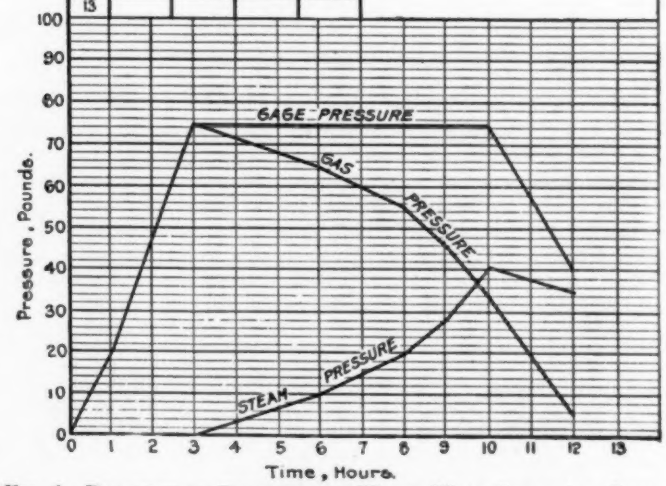

FIG. 1 REACTION IN DIGESTERS IN WHICH WOOD CHIPS ARE COOKED

general impression of his progress from day to day. Several good records for one day are only like so many good golf drives. They are a source of satisfaction at the time; but just as the score in golf denotes our real mastery of the game, so does the progress record measure the man's increasing mastery of his work, and we feel that it is one of the moral obligations of the management to keep such records for the individual workman.

* * *

Such records can be grouped under three main headings: quantity records, quality records and economy or cost records. Quality records, which occupy the middle position, are, perhaps, of the greatest importance, for they bring the individual's intelligence to bear upon the problem, and as a consequence, by removing the obstacles to uniformity of quality, remove at the same time the obstructions to increased output. The creative power of the human mind is, however, not content simply to produce the best quality under existing conditions of plant operation. The desire to create new conditions for the more highly specialized working out of the natural laws of the process demands expression, and this expression at once takes the form of suggestions for improvements in mechanical devices.

This desire contains within it the germ of economic thought which will unfold and express itself eventually in a request for cost records, and the organization that neglects its opportunity to satisfy this desire is overlooking one of the great avenues leading toward intelligent productive effort.

Because of the interrelation of quality, quantity and economy records, any complete record of individual progress must, of course, take them all into account. However, as this is not always practical, we have at least one of three ways of measuring progress always open to us.

Table 1 shows how we keep a continuous progress record of the work, which is mainly one of quality. By quality I do not necessarily refer to the quality of the material produced, as most of our records refer to the quality of the work performed; in other words, the nearness to which the workman approaches the ideal standards which he has helped to form. The democratic coöperative forming of these standards by the joint work of the trained technician and the practical workman is absolutely essential, otherwise continuous progress will not be made. The whole plan must be really educational in nature, and to be so the records must record the natural laws of the process and the individual's degree of control of forces in the material elements that he is using. The more factors that can be recorded, the greater the interest in the work. The reason for this is obvious.

Referring again to Table 1, it will be noted that there are nine men cooking. These men are posted in the order of seniority, with the highest monthly record on top. There are three foremen at the top of the record. Each of these foremen has three cooks under him, and their standing is made up by taking the average records of the men under them. In this way we are enabled to get not only the individual records of the men, but the group, or teamwork records, as well. The lower group is merely for the convenience of the department head in charge and gives the relative standing of the large, medium and small digesters. This is irrespective of the men who are working on them.

The total progress record figures in the first column are made up of the temperature, color, time and blowing records. The relative values that these have in the total record are shown at the top of each column, the total adding up to 100. The small variation in the monthly average column is characteristic of all our progress records, and shows how great is the incentive when individual effort is intelligently recorded.

The temperature record is obtained by taking half-hourly readings from the recording-thermometer chart, upon which a standard temperature curve has been plotted, calling each reading which happens to fall on the standard line 100, and a reading 20. deg. either side of the standard line 0. For each degree off of the standard, 5 points are deducted from the progress record.

The color record indicates how near the men come to blowing the digester when the color of the liquor shows the proper amount of lignine in the solution. The sample, drawn from the side of the digester, is compared with the standard color. To get a mathematical value for this factor, a range of colors from a very dark to a very light was obtained, the particular shade which was taken as standard marked 100 and one shade either side 10 points less than 100.

The time record is obtained by calling a certain time of cooking 100, and taking off on each digester cooked one point for each minute above or below this standard.

The blowing record is obtained by calling 30 lb. pressure 100 (most of the cooking being done at a pressure of 75 lb. per sq. in.) and 60 lb. 0, the idea being to get the pressure as low as possible before blowing the digester.

It will be noted that the temperature value is higher than any of the others. This is because it is the most important element. The color record coming next in importance is given the next highest value, etc.

TABLE 1 RECORDS OF INDIVIDUAL COOKS

Date, June 2, 1916.

Name	Total Progress Record		Relative Value 50 Temperature Record		Relative Value 35 Color Record		Relative Value 10 Time Record		Relative Value 5 Blowing Record		General Information: Average Maximum Temp.		General Information: Average Test 5th Hour 1.25		General Information: Average Test 6th Hour .80	
	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.	Daily Avg.	Mo. Avg.
Myler	88.2	88.3	84.8	85.9	99.3	98.3	90.6	88.6	58.8	59.5	293.6	294.7	139	134	100	103
Duggan	86.2	87.7	81.8	85.1	96.4	97.7	95.3	91.9	59.2	60.8	299.0	298.5	134	133	96	95
S. T. Ellis	85.8	87.1	79.1	83.2	98.8	97.7	95.1	93.8	57.9	59.7	299.8	299.6	125	129	101	102
Rodgerson	86.7	89.3	83.3	88.2	99.2	99.0	92.5	88.8	64.3	62.1	296.2	294.7	161	134	105	103
J. P. Ellis	89.5	88.7	87.2	86.8	96.7	97.7	96.7	94.8	56.3	62.0	294.7	297.2	123	129	94	96
McKee	88.8	88.3	84.8	86.0	100.0	98.9	90.5	90.0	56.4	59.9	294.4	294.7	132	133	96	101
Teeling	88.0	88.2	84.2	85.9	100.0	98.5	92.8	90.7	62.0	61.0	299.5	298.3	128	135	91	104
McKelvy	83.1	87.1	77.1	84.4	96.0	97.8	93.3	89.0	62.0	60.5	204.3	298.8	122	129	96	97
Element	84.9	87.2	79.1	83.8	96.7	97.7	95.2	92.2	59.3	59.9	297.8	299.7	130	131	98	95
McLean	83.9	87.2	75.3	81.9	98.8	99.1	97.8	93.3	59.2	57.8	306.4	302.1	137	134	109	102
Johnson	85.4	86.4	77.9	82.2	97.5	96.1	94.4	97.0	52.3	60.2	294.5	296.3	136	131	102	101
Neil	89.2	86.1	89.2	86.1	86.3	83.7	98.8	96.8	54.6	56.3	289.3	294.4	130	133	100	105
Large	86.6	87.4	82.0	85.5	98.5	98.3	91.9	87.0	59.8	59.9	299.0	296.4	129	133	95	100
Medium	87.2	87.9	83.3	85.7	98.5	97.7	94.9	91.8	58.6	61.6	295.2	296.9	134	132	99	99
Small	85.9	86.5	80.1	83.1	98.2	97.9	94.9	88.3	57.6	58.3	298.4	299.3	131	133	102	100

* * *

In the plant where this system was developed were employed over 1200 men, and perhaps half of these men had individual progress records and the rest came under some sort of group progress record. Invariably the records proved themselves to be an incentive to greater productivity.

* * *

Fig. 2 shows the concrete results obtained by giving the cost sheets to the department heads and job costs to the maintenance foremen. There was a rapid increase in production from 1908 to 1913, also a rise in repair material used, as well as an increase in the cost of maintenance labor. The fourth curve, showing the amount of material used for each dollar spent for maintenance labor, is more or less a resultant of the other two. The gradual rise from 1908 to 1911 in this curve was due to the increased material-consuming power of the maintenance men because of the introduction of labor-saving devices, such as pneumatic and electric portable tools. There was a drop in this figure in 1912 and 1913, but we were unable to get a real thought of economy started in the plant until the departmental cost sheets and job cost sheets were started. These were put into effect first in the beginning of 1914, and there was an immediate drop in the curve from an average of about $2.35 worth of material spent for each dollar spent for labor, down to $1.55 in 1914 and $1.05 in 1915.

The drop in production in 1914-15 was due to war conditions which were unavoidable. It is a significant fact, however, that in spite of this drop in production the maintenance material cost per ton of pulp was reduced to approximately half the amount under

the conditions of higher production during the two preceding years.

In none of this work did we pay bonuses to a superintendent, department head or workman; our salaries and wages were high, but payments were all on a monthly, weekly or hourly basis. The increased effort, therefore, came entirely from a desire within the individual to be productive. Of course, this sort of creative effort produced great changes in operating conditions—we increased our yearly production from 42,000 tons to 111,000 tons without adding to the number of digesters for cooking the pulp, or wet machines for handling the finished product, and we changed our quality from the poorest to the very best.

* * *

We should never lose sight of the fact that the degree of conscious self-expression which the workman can attain is in direct proportion to the ability of the organization to measure, for his benefit, the impress of his personality upon it. The most democratic industrial plant, therefore, is the one which permits the fullest possible amount of individual freedom to each member, irrespective of his position, and at the same time is so sensitively adjusted that it reflects immediately the effects of his actions. If his actions result in injury to others he will see that as a part of the whole he, himself, must also suffer.

* * *

Man is not an animal, but a free, self-determining mental center of consciousness whose reason for existence is that the universal life can deal with a particular situation in time and space, and by this means be enabled to evolve a material universe organized to express the one great individual life of which we are all a part.

In conclusion let me say that I am well aware that to some of you this may seem like pure philosophical speculation far removed from the practical affairs of everyday life. I have said nothing, however, that I cannot back up by any number of additional illustrations, and my hope is that the examples given will stimulate others to make similar investigations, so that we can fulfill our mission in this country by evolving an industrial

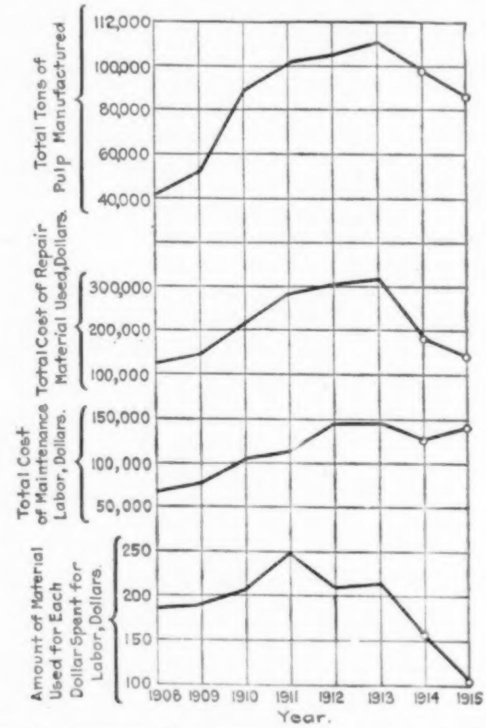

FIG. 2 SHOWING CONCRETE RESULTS OF COST SHEETS

philosophy which will have for its ultimate aim the continuous unfoldment of the latent powers in man.

UNIFORM BOILER LAWS

BY E. A. BROOKS,[1] ATLANTA, GA.

IN 1914 there were between five and six hundred people killed outright, some fifteen hundred injured, and several millions of dollars in property and production lost in this country through the needless explosion of boilers. I say "needless" explosions after due consideration, for it is a fact that the majority of these occurred where the boilers were not subject to regular inspection either by the state or by insurance companies.

One experience is enough to convince any one that safe boilers are altogether desirable. One morning when passing down a line of boilers in my charge I was startled to observe that the steam pressure on one boiler was 300 lb. per sq. in. It developed later that one bright water tender had, through ignorance, oiled the safety valves! Of course the oil evaporated and stuck the safety valves to its seat. But knowing this did not help the situation at that time one bit, but what did help was the fact that the boiler was built with a *safety factor of five,* as is prescribed by the A.S.M.E. Boiler Code.

There has been a strong feeling all over the country for proper legislation along the line of safer boilers. Our Society felt this need and set its wonderful resources to work to formulate laws for this purpose, which, while providing a maximum of safety for the users and public, would not in any way put an undue hardship upon the boilers. This was completed and is now known as the A.S.M.E. Boiler Code. It has been conservatively estimated that this code, if paid for at consultation rates, would have cost $250,000.

As The American Society of Mechanical Engineers is precluded from engaging in public campaigns relating to legislative matters, The American Uniform Boiler Law Society was formed to secure the adoption of the A.S.M.E. Code in its entirety in the various states and to promote the manufacture and sale of safer boilers. This new society is an organization of boiler manufacturers and users and as far as possible is representative of every branch of the boiler industry.

The enactment of boiler laws by the various states is not new at this time. Through the influence of the members of this Society and others the state of Massachusetts passed a bill governing the use and installation of boilers in 1907. Since that time there have followed New York, New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Minnesota, California, the U. S. Navy and other branches under Government supervision.

From the manufacturers' angle we can readily appreciate that through standardization the small manufacturer would be given the benefit of the years of research and study of some of the brightest engineers in the country, while the large manufacturer would be given the benefit of large-scale standardized construction. The purchaser of boilers, while not conversant with boiler construction, could feel reasonably safe in buying a boiler coming under the A.S.M.E. Code requirements so far as safety is concerned. This does not mean that all boilers would be equally safe. It simply means that for the type of boiler under consideration the purchaser could feel that it was built as safely as that particular construction would allow.

At the present time there are in force quite a number of boiler laws for the different states. It is not unusual to see a boiler stamped as good under Massachusetts boiler laws, the laws of Ohio, or the city of Cincinnati. This brings us fact to face with a very vital necessity, namely, that of *standardizing these laws.*

Unless the states which have not passed boiler laws wake up to their responsibilities, all the old, second-hand boilers from

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their progressive sister states will find a sale in them and will be a source of unending trouble. Boilers do not stand very well being ripped out of their original settings and being reset. Every year the records indicate quite a number of explosions from this very cause alone.

The active work so far done in our state of Georgia was started by Mr. Chas. E. Gorton, Chairman of the American Uniform Boiler Law Society, on a visit in the south this year. He interviewed many of those interested, and as a result State Senator Wohlwender of the 24th district introduced in the state senate a bill covering Mr. Gorton's recommendations. The bill was referred to a Committee on Commerce and Labor.

Inasmuch, however, as this session of the legislature was an adjourned session and there were a large number of bills before the assembly, this bill was never reported out of the committee. The Commissioner of Commerce and Labor was, however, favorable to the bill and it had his entire approval. The text of the bill is given below in the belief that it will prove of value to engineers in other states who are considering the question of boiler standardization:

Senate Bill No. 258. by Mr. Wohlwender of the 24th. Commerce and Labor.

An Act to establish a State Board of Boiler Rules in the State of Georgia; to define the duties and powers of said Board; to pro- the use of steam boilers in this state; to provide for the appointment of Boiler Inspectors; to provide penalties for the violation of this Act, and for other purposes.

Be it enacted by the General Assembly of the State of Georgia, and it is hereby enacted by authority for the same:

Section 1. There is hereby created a State Board of Boiler Rules in the State of Georgia, to be known and styled as the Georgia State Board of Boiler Rules.

Section 2. Said board shall consist of three members. The Commissioner of Commerce and Labor of the State of Georgia shall be ex-officio one of such members, and shall be chairman of such board. Within ten days after the passage of this Act it shall be the duty of the Governor of this state to appoint two members of said board. One of said members to be appointed by the Governor shall be a man who shall have been actively engaged in the manufacture of steam boilers in this state for the period of three years prior to his appointment and the other of said members to be appointed by the Governor shall be a man who shall have been actively engaged in a business in this state requiring the use of steam boilers in the operation of said business for a period of three years prior to his appointment. Within ten days after any person shall be notified of his appointment as a member of said board by the Governor he shall accept or decline said appointment and upon his acceptance he shall subscribe and forward to the Governor the following oath: "I do swear that I will faithfully and impartially perform the duties of a member of the Georgia State Board of Boiler Rules to the best of my ability, so help me God." Upon such oath being filed in the office of the Governor he shall issue to said member a certificate of his appointment.

Section 3. From the fund derived from inspection fees provided for in Section 6 of this Act, the members of said Board of Boiler Rules shall be allowed and paid their reasonable traveling expenses incurred in attending to the business of such board. No member of the board shall receive any compensation for his services except the Secretary-Treasurer, who may be paid a reasonable compensation for his services as such, payable from the fund derived from inspection fees as provided for in Section 6 of this Act.

Section 4. The term of office of each member of said board to be appointed by the Governor shall be three years, subject, however, to the following provisions: Of the two first appointments to be made by the Governor to membership on said board one shall be made for the period of two years and one for the period of three years, and after the expiration of the terms of office of the members so first appointed each subsequent appointment shall be for a term of three years, and any vacancy that may occur for any cause shall be filled by the Governor for the unexpired term. The person who may be appointed to any vacancy on said board shall possess the same qualifications for membership on said board as those required by this Act of his predecessor in office.

Section 5. The first meeting of said board shall be held within thirty days after the appointment of the first two members of said board hereinbefore provided to be appointed by the Governor, and at a time and place to be designated by the Commissioner of Commerce and Labor of this state. At its first meeting and annually thereafter said board shall elect from its membership a vice-chairman and a secretary-treasurer ,each of whom shall hold his office until his successor is elected and qualified. The secretary-treasurer shall give a bond in such sum as the board may determine. Said board shall prescribe such rules and regulations for its proceedings and government as will carry into effect the provisions of this Act. There shall be at least two meetings of such board held each year on the second Wednesday in January and July. Special meetings may be held on the call of the chairman of the board. A majority of said board shall constitute a quorum. Said board shall keep a record of its proceedings and a register containing the names and addresses of all persons, firms and corporations to whom permits shall be issued allowing steam boilers to be used or operated in accordance with the provisions of this Act and the rules and regulations prescribed pursuant to the same.

Section 6. The said Georgia State Board of Boiler Rules is hereby charged, directed and empowered:

To formulate and publish rules and regulations for the safe and proper construction and use of steam boilers in connection with manufacturing and industrial enterprises in this state, such rules and regulations to conform as near as may be practicable in the judgment of said board with the Boiler Code of The American Society of Mechanical Engineers.

The rules and regulations formulated and published by said Board of Boiler Rules shall become effective on and after the approval of the same by the Governor of this state. Rules requiring a change in methods of construction of boilers or in the character of materials used shall not be enforced until six months after their approval by the Governor. The provisions of this Act shall not be construed to apply to boilers installed prior to the time when this Act becomes effective, except in so far as the same become necessary, in the judgment of said board, to protect life and property. After any of such rules and regulations so formulated and published by the board and approved by the Governor shall become effective, no steam boiler for use in connection with manufacturing or industrial enterprises shall be installed in this state which does not conform to such rules and regulations.

To employ a Chief Inspector of Boilers and such deputy inspectors of boilers as in the judgment of said board may be necessary, and such office help as in the judgment of said board may be necessary, and to fix the compensation of such inspectors and office help, such compensation to be paid from the fund derived from inspection fees provided for in Section 6 of this Act. Such Chief Inspector shall possess qualifications which shall be prescribed by said Board of Boiler Rules, and each deputy inspector shall be appointed only after he shall have satisfactorily passed in the judgment of said board a written examination as to his fitness for such position, which said examination shall be conducted in accordance with such rules and regulations as may be prescribed by the said board.

To issue and revoke permits allowing boilers to be operated in accordance with the provisions of this Act and the rules and regulations prescribed pursuant to the same.

To keep a complete record of the type, dimensions, age, conditions, pressure allowed upon, location and date of last inspection of all boilers to which this Act applies.

To fix the fees to be paid by the owners and users of boilers to be inspected under the provisions of this Act and the rules and regulations prescribed pursuant to the same, provided that no fee for the inspection of any boiler internally and externally inspected shall exceed the sum of five dollars per inspection, and provided, further, that not more than ten dollars shall be collected for such inspections of any one boiler during any one year.

Section 7. In addition to the inspectors authorized by Section 6 of this Act, the board shall upon the request of any company authorized to insure boilers in this state, issue to any boiler inspectors of said company commissions as special inspectors of the Georgia State Board of Boiler Rules, but such special inspectors shall receive no compensation from, nor shall any of their expenses be paid by, said board, and the continuance of a special inspector's commission shall be conditioned upon his continuing in the employ of a duly authorized boiler inspection and insurance company, and upon his maintenance of the standards imposed by the rules and regulations prescribed pursuant to this Act for the construction and operation of boilers. Such special inspectors shall inspect all boilers insured by their respective companies, and issue permits for the operation of such boilers, copy of which he shall transmit to the Board of Boiler Rules, and such insured boilers shall be exempt from all inspection, other than that of the respective insurance companies' inspectors. Each special inspector shall within ten days following each annual inspection made by him report the date thereof to the Board of Boiler Rules.

Section 8. All fees for inspections of boilers provided for under Section 6 of this act shall be paid in advance to the Secretary-Treasurer of the said board to be held as a fund for the use of said board. No funds shall be paid out except on a warrant signed by the chairman and the secretary-treasurer of said board and no expense of any character shall be created in excess of the amount derived from fees to be fixed in accordance with the provisions of Section 6 of this Act. The funds derived from such fees shall be applied by the board to the compensation of members appointed by the Governor as provided in Section 3 of this Act and to expenses of operation of said board including compensation to be paid inspectors and office help. All surplus on hand on January 1 of each year, after paying all expenses of the operation of said board, shall be turned into the State Treasury.

Section 9. The provisions of this Act shall not apply to boilers in marine or railroad service that are under the inspection regulations of the United States Government, or to motor road vehicles, or to boilers of fire engines brought into the state in an emergency to check conflagration, nor shall it apply to boilers used exclusively for low-pressure steam and hot-water heating and boilers used exclusively for

hot-water supply, carrying a maximum allowable working pressure not to exceed 45 pounds per square inch on boilers used exclusively for low-pressure steam heating, and not to exceed 30 pounds per square inch on boilers used exclusively for hot-water heating or hot-water supply.

Section 10. Any person, firm or corporation violating any of the provisions of this Act or any provisions of the rules and regulations prescribed pursuant to the same shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined not exceeding one hundred dollars or imprisoned for not exceeding three months in the discretion of the court.

Section 11. The rules and regulations to be prescribed by said Board of Boiler Rules pursuant to this Act shall become effective on January 1, 1919.

Section 12. Be it further enacted that all laws and parts of laws in conflict with the provisions of this Act be and the same are hereby repealed.

In conclusion, we find that the only effects that the adoption of the laws would have on the present installations would be to render them safe through the inspection of regular inspectors of the state or insurance companies.

All new boilers would conform to the code as prescribed by this Society.

We can each do our part by getting behind the organizations which we represent and get them to do their part through members of the state legislature. We should each ask ourselves if we are willing to sit still and see this law, which would uplift our state as outlined, tabled again at the next session of our legislature. Practically all the boiler manufacturers represented in Georgia are prepared to build code boilers, and it will take only our concerted efforts to put this bill through next year.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 200-206, inclusive, as formulated at the meeting of October 25, and approved by the Council. In this report, as previously, the names of inquirers have been omitted

CASE NO. 200

Inquiry: Can the requirements of Par. 312 of the Boiler Code be construed to imply that protecting coverings of non-conducting material may be removable the same as if a cast-iron removable sleeve were used? A literal interpretation of the paragraph as worded would seem to indicate that only a cast-iron protecting sleeve may be removable.

Reply: It was not the intent of the Committee to limit the application of the term "removable" to any particular form of protecting covering, as it is obviously desirable that any form of covering should be easily removable for convenience of examination of the blow-off pipe.

CASE NO. 201

Inquiry: May rivets be used where the heads are not of the form required by Par. 255 of the Boiler Code (Edition of 1918), which refers to specific forms of rivet heads that are acceptable under the rules, but where they are driven with forming tools which bring the final form to any one of the acceptable forms of heads shown in Fig. 20?

Reply: The requirements of Par. 255 may be considered as fully met if the form and proportions of the finished heads correspond to those indicated in Fig. 20 of the Boiler Code (Edition of 1918).

CASE NO. 202

Inquiry: What is the correct method under the rules of the Boiler Code (Edition of 1918) of calculating the safety valve requirements for waste-heat boilers used in connection with the manufacture of illuminating gas, in which the boilers are driven alternately during the blow periods of water-gas machines, and in which there are occasions when the tarry deposit from the gas must be burned off the heating surfaces, producing a temporary extremely high rate of local heating?

Reply: The minimum number and size of safety valves required for these boilers as in other boilers, is determined by Par. 274. In this case the Committee considers this safety valve capacity should be checked by Par. 275*a*, and if found insufficient should be increased.

CASE NO. 203

Inquiry: Will an automatic fire door which consists of a metal plate or plates that slide within retaining guides or grooves, meet the requirements of Par. 328 of the Boiler Code in which specific reference is made only to doors of the inward-opening type or those which are provided with a substantial and effective latching device? A sliding door of the type above described, obviously is neither of the inward-opening type nor has it any latching or fastening devices.

Reply: The intent of the requirements in Par. 328 was that means shall be provided to prevent the firing or inspection door "from being blown open by pressure on the furnace side," and the ruling is therefore not limited to the specific types of mechanisms named. If a door is so constructed that it cannot be blown open by pressure on the furnace side, no matter in what position it may be found, it obviously meets the requirements of Par. 328.

CASE NO. 204

Inquiry: An interpretation is requested of what may be considered a "substantial and effective latching or fastening device" for firing or inspection doors to prevent them from being blown open by pressure on the furnace side. Does an over-balanced weighted form of latch which is so fitted to the fire door fulcrum that it cannot jump out of latch when the door is closed under any conditions, meet the requirements of this rule?

Reply: The intent of the requirement in Par. 328 was that means shall be provided to prevent the firing or inspection doors "from being blown open by pressure on the furnace side." If a door is so constructed that it cannot be blown open by pressure on the furnace side, it obviously meets the requirements of Par. 328.

CASE NO. 205

(In the hands of the Committee.)

CASE NO. 206

Inquiry: Is it permissible, in bracing the rear lower segment of an h.r.t. boiler, to so design the angle irons of the structural reinforcement used across the rear head for attaching through braces, that they may also be considered as taking the place of a certain amount of through stay area.

Reply: The practice referred to in the inquiry is permissible if the members are designed in accordance with the requirements for structural reinforcements in Par. 201 of the Boiler Code (Edition of 1918).

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, Including Abstracts of Articles in Current Technical Periodicals

Boring for Oil in Britain

WHAT may be called the inauguration of the crude-oil industry in the United Kingdom took place in October. A public ceremony on the Duke of Devonshire's estate, about seven miles south of Chesterfield, marked the beginning of the first boring operation.

American aid is figuring prominently in the situation. Not only has most of the machinery to be used been imported from the United States, but forty drillers have been brought over and will work under the supervision of one of the foremost oil experts of America.

The scheme originated in the enterprise of Lord Cowdray, head of the firm of S. Pearson & Son, Ltd., who has placed at the disposal of the British government the services of the firm's geological experts and the information which they have accumulated. The firm is now directing the work as agents of the Ministry of Munitions.

What has been done is all preparatory work. It throws no additional light on the probabilities of oil being found. The boring of the wells, a long and expensive process, is the only decisive test. But Lord Cowdray and those with him have great confidence in the accuracy of the conclusions which the experts have made. These conclusions are based on a study of the geological formation of the district, and they have not been hastily drawn. Investigations were begun in 1914 under the direction of Dr. Veatch, an American petroleum expert, who was formerly connected with the United States Geological Survey.

A considerable time must elapse before the success or failure of this first well can be determined. (*Journal of Commerce*, Nov. 1, 1918, p. 2)

Output of New Locomotives Doubled in Three Months

B. M. Baruch, Chairman of the War Industries Board, authorizes the following:

The standard-gage steam-locomotive industry of the United States, operating under the direction of the War Industries Board, has increased its rate of production approximately 100 per cent in the past three months. Last week the output of the three standard-gage companies was 144 locomotives. Since 1910 and up to last August, the highest number ever turned out in a single year was 3776, which would prove an average weekly output of 72.6 locomotives.

The achievement is particularly noteworthy from the fact that, in bringing about the tremendous jump in production, it has been unnecessary to expend a dollar to increase plant facilities or enlarge the existing works, items of considerable expense in the development of most of the other war industries of the country. Redistribution of orders and concentration by each of the plants on particular types of locomotives has made possible the intensity of effort unprecedented in the industry.

The "Pershing" locomotive, built on standardized plans designed by the United States Military Railways, has not only been made the sole type of steam locomotive in use behind the American lines in France, but, at the instance of the War Industries Board, has been adopted by the British and French governments as the standard type for their armies on the western front.

Last August the Government, face to face with an immediate and urgent demand for steam locomotives for use in this country and France, was seriously considering the establishment of Government plants to meet the emergency. It was proposed that approximately $25,000,000 should be spent for this purpose. At the suggestion of the War Industries Board the expenditure was held up in favor of the present plan.

Under the arrangement adopted, the construction of all the locomotives of standard gage for use in France was assigned to the Baldwin Locomotive Works, whereas all orders for the United States Railroad Administration were divided between the American Locomotive Co. and the Lima Locomotive Works. These three companies comprise the entire standard-gage steam-locomotive industry of the country. By this method of distributing the work, each of the plants has been able to develop extraordinary speed.

Normally the output of the Baldwin Works never exceeded 60 locomotives a week. Last week it turned out 87 engines complete, not to mention 7 gasoline locomotives and 3 electric locomotives, and general repairs on ten steam engines, and the promise is for even better returns during the present month. The American Locomotive Works has likewise accomplished excellent results, for while the number of locomotives is not so great, the tonnage represented in the output is proportionately as large; that is to say, whereas the "Pershing" locomotive weighs about 83 tons complete, the average weight of the locomotives called for by the Railroad Administration is approximately 150 tons. Similarly the Lima Works have developed to a marked degree in the last three months; and, as in the case of the other two concerns, without e pansion of plant or plant facilities.

The importance of the results attained in this direction in their relation to the war program generally is indicated by the fact that the Government is spending this year in the construction of these locomotives, both for use in France and on the Government-operated roads in this country, approximately $200,000,000. (*Official Bulletin*, Nov. 2, 1918, p. 1)

British Machine Tools

A British author, J. Judson, recently delivered an address in England containing some rather startling statements. According to this speaker, the British tool industry had been practically stationary during the last quarter of a century before the war, while Germany and America made big strides ahead.

As an illustration, he stated that from 70 to 80 per cent of the machinery used in the manufacture of British aircraft engines is of foreign make. The largest machine tools to be found in Great Britain at the present time (purchased before the war, of course) are of German make.

During 1917 the output of German machine tools was about $200,000,000, while the British output is estimated at only one-quarter of that amount. This tremendous output of German machine tools was necessary to keep up with the demand for munitions of war. Because of the British blockade on the seas the Germans were unable to draw machine tools from America as the British did, and were obliged to make everything for themselves in this particular line. As a result, a very important group of machine-tool makers may appear in the field after the war. (*The Iron Age*, vol. 102, no. 20, November 14, 1918, p. 1199)

Fuel-Oil Conservation Meeting at Chicago

A meeting was held on October 24, which was attended by about 300 representatives from fuel-oil and coal-burning plants in the Illinois district, assembled at the request of Nelson G. Phelps, District Engineer of the Bureau of Oil Conservation. The primary object of the meeting was how to arouse interest in the conservation of oil, to point out wasteful practices and to indicate where improvements might be made. Four technical papers relating to fuel-oil systems were presented.

Max Sklovsky gave information on the use of fuel oil in industrial furnaces and the results of experiments obtained over a period of years by the Deere Company, of Moline, Ill. He stated that improvements in efficiency had been secured by preheating the air of combustion by the waste gases from the furnace to a temperature approximating 700 deg. fahr. The oil was injected

into this air in a mixing receptacle, vaporized and thoroughly mixed with the proper proportion of air and was delivered to the furnace in gaseous form. The furnace should be airtight. A comparison between the old straight-type furnace and the new furnace burning the oil in the form of gas and preheating with waste heat, showed that the oil consumption was reduced to practically one-third of the quantity formerly required.

J. J. Connelly, in a paper entitled Oil Storage and Measurement, made practical suggestions in reference to storage tanks, pipe lines to the furnaces, and meters to measure the oil used. He emphasized the necessity of having some method of measuring the oil consumption, and called attention to the fact that by no means had all the plants provision for measuring the oil consumed or for determining what economy was being obtained.

Fuel-Oil Combustion in Industrial Furnaces was the title of a paper by Joseph W. Hays, Mem.Am.Soc.M.E. He compared fuel-oil firing with coal burning, enumerated in a general way the conditions required for efficient combustion, and made a strong plea for the use of CO_2 recorders. (Abstracted through *Power*, vol. 48, no. 19, November 5, 1918, pp. 684-685)

American Institute of Electrical Engineers

A meeting of the Institute was held in New York on November 8, 1918.

A paper was presented by R. B. Williamson, C. A. Kelsey, A. M. Dudley and H. Veichsel, acting as a sub-committee of the Industrial and Domestic Power Committee, appointed to compile a typical survey of the application of electric motors to a representative industry, standardizing methods for the selection of motors. This survey is expected to serve as a model for the survey of this phase of other industries.

The paper begins by giving a brief description of the process of manufacturing cement, which is followed by an outline of the various kinds of machinery used, together with data as to power requirements. From this outline it appears that the grinding of the clinker into finished cement requires more power than any other step in the process, as the clinker is, as a rule, much harder to grind than the raw materials. Further, there is at present a tendency to demand more finely ground cement, specifications for portland cement in the United States having been changed in 1916 from 75 per cent through 200 mesh to 78 per cent through 200 mesh. There is also a greater tendency to grind the raw material extremely fine, and it is claimed that the extremely fine grinding of raw materials has the advantages that fuel is saved, a better cement is produced, and the clinker is more easily ground.

As regards motors, it is stated that alternating-current motors are preferable for cement-mill operation. There are two main reasons for this: (1) A relatively higher voltage can be used—from 440 or 550 volts up to 2200 volts for some of the motors in large mills; and (2) the greater mechanical simplicity of the a. c. motor, particularly that of the squirrel-cage type. There are, however, a number of mills equipped with d. c. motors which give excellent service.

A number of recommendations are given for guidance in selecting motors for a cement mill. Among these are the following: Starting conditions are quite severe and make phase-wound rotor motors preferable or even essential; bearings should be made dustproof, as cement has a highly abrasive action; it is good practice to supply outboard bearings for belted motors of 75 hp. and larger; pulleys larger than usual in both diameter and length are often specified, since the cement dust causes more than normal belt slippage and makes necessary tighter belts and increased strain on bearings.

As regards the type of motor, it is stated that while the induction motor has been used almost exclusively in the past, there are indications that synchronous motors will be adapted to this work more in the future. This is especially so in the case of low-speed motors for geared tube mills.

The load factor of the average complete cement plant runs from 65 to 75 per cent taken through the entire year, and is probably the highest of any industry. It may be as high as 95 per cent, since the machines run at all times under constant full load.

An interesting description and discussion of the various types of crushers, crushing rolls, rotary driers and grinding machinery is presented, making the paper of considerable interest not only to electrical but also mechanical engineers.

The complete paper is published in the Proceedings of the American Institute of Electrical Engineers, vol. 37, no. 11, November 1918, pp. 1237-1273. The discussion has not yet been published.

Society of Naval Architects and Marine Engineers

The 26th annual meeting of the society was held in Philadelphia, Pa., on Thursday and Friday, November 14 and 15, 1918. Excursions were arranged to various shipyards on the Delaware River, and the following papers of special interest to mechanical engineers were presented:

Application of Buoyancy Boxes to S. S. *Lucia* for the U. S. Shipping Board, W. T. Donnelly, Mem.Am.Soc.M.E.

On Vibrations of Beams of Variable Cross-Section, N. W. Akimoff, Mem.Am.Soc.M.E.

Experiments Upon Simplified Forms of Ships, Prof. H. C. Sadler and T. Yamamato

Variation of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient with Longitudinal Position of the Parallel Middle Body in a Single-Screw Cargo Ship, Commander Wm. McEntee

The Application of Electric Welding to Ship Construction, H. Jasper Cox.

Abstracts of these papers will probably be published in an early issue of THE JOURNAL.

Society of Automotive Engineers

At a meeting of the Mid-West Section of the Society of Automotive Engineers, in Chicago, November 8, P. J. Dasey presented a paper on Lubrication and Fuel Tests on the Buda Tractor-Type Engines.

In this paper a statement was made that there would probably be commercially available in a short time a new fuel, a reworked petroleum product, which would cost much less than gasoline, but which, except for ease of starting and for extremely high-speed engines, is claimed to have as good power and fuel-economy characteristics as gasoline.

This product Dasey calls "synthetic crude," and his paper was devoted chiefly to reports of careful tests in the Buda laboratories of this fuel in comparison with four other fuels, namely, gasoline, cracked benzine, cracked gasoline and kerosene. These tests were made on the new Buda tractor engine model HTU, using a standard Stromberg carburetor.

Summarizing the tests on these fuels and averaging the results of five runs on each fuel for power and economy at different speeds, he found the following in brake horsepower-hours per gallon:

Commercial gasoline	7.80
Cracked gasoline	7.92
Synthetic crude	8.02
Cracked benzine	8.23

(*Motor World*, vol. 57, no. 7, November 13, 1918, p. 33)

Child Labor Increasing

Investigations recently conducted by the Children's Bureau of the Department of Labor show that there has been a great increase in child employment since the Federal child-labor law was declared unconstitutional last June. In twenty-four states, including Pennsylvania, the southern textile states and New England, except Massachusetts and Vermont, the reports indicate there has been a general return to the nine-, ten- and eleven-hour day for children under sixteen years of age. In these states the eight-hour day is not required by statute for children between fourteen and sixteen years of age. Philadelphia *Public Ledger*, Nov. 6, 1918, p. 10)

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

For Articles on Subjects Relating to the War, see Aeronautics, Military Engineering, Munitions, Refrigeration, Testing, etc.

Aeronautics

Battle Acrobacy or Trick Flying, Capt. K. G. Pulliam, Jr., U. S. A. Description of the various forms of "stunt" flying written by the authority of Air Service Headquarters, A. E. F.

The object of training fighting pilots in stunt flying is to teach them how to meet dangerous conditions of flight which they may encounter (Gosport system of training).

At a field where trick flying is taught every student is given individual attention and instruction. Only one stunt at a time is explained and unless every movement is thoroughly understood by the student he is not permitted to attempt the work.

The Vrille. This is one of the most disconcerting of all stunts and is the first to be taught. In starting the pilot ascends to at least 1200 meters and after flying level for several minutes throttles his motor and just at the point where the machine stalls he pulls the control stick quickly back toward him and at the same time to the side, accompanying it by a sudden push of the rudder bar, using the foot corresponding to the side on which the stick is placed.

As a result the machine shoots suddenly up, losing speed, and falls sharply over to the side with a twisting corkscrew-like movement. In every case the twist commences sharply and the student is instructed to place his controls in neutral after the machine has made several turns and to *slowly* push the control stick forward a few inches. The machine ceases to whirl, points forward and dives straight down, the pilot at once redressing his control stick and bringing his machine again into horizontal flight, at the same time switching on the motor.

The Renversement. Although the use of this stunt in actual combat is questionable the student should be familiar with it, as any pilot who can manage it will be able to control his machine whether or not he is in an upside-down position.

To perform the renversement the pilot ascends to the height of 1200 meters, flies for a few minutes, then points the machine *very* slightly downward so as to bring the speed up to maximum, pulls the control stick back sufficient to raise the nose of the machine to an angle of 20 or 30 deg. If a left-hand renversement is desired the rudder should be pushed hard to the left. As a result of the above control motions the nose of the machine jerks sharply upward, followed by a roll of the entire machine to the left. Just before the machine is completely on its back the motor is cut and the pilot places his controls in neutral; the plane stops its roll and the pilot pulls back on the control stick, causing the machine to dive and almost at once resume the horizontal, at which time the motor is switched on, the stick placed in neutral and normal flight resumed.

Since the pupil when flying in the head-down position in which he hangs when the machine is on its back, is not likely to recognize the moment at which the controls should be placed in neutral, he is instructed to immediately neutralize the rudder after he has thrust the control to the left.

The Immelman Turn. This stunt was first used in combat by Lieutenant Immelman of the German Flying Corps. To perform the Immelman turn the pilot again ascends to the height of 1200 meters and after flying level for a few minutes he points the nose of the machine down very slightly and then pulls slowly back the control stick, causing the machine to climb almost vertically. Care should be taken not to pull enough on the stick to cause the plane to loop. The motor should be cut as soon as the machine starts to climb and as soon as excessive loss of speed is felt the rudder is pushed sharply to one side. The machine falls to the side on which the rudder is pushed and as soon as the machine reaches vertical the pilot places the rudder in neutral, switches on the motor and by pulling back on the stick resumes normal flight. A slight movement of the stick to the side corresponding to the rudder used will help the movement.

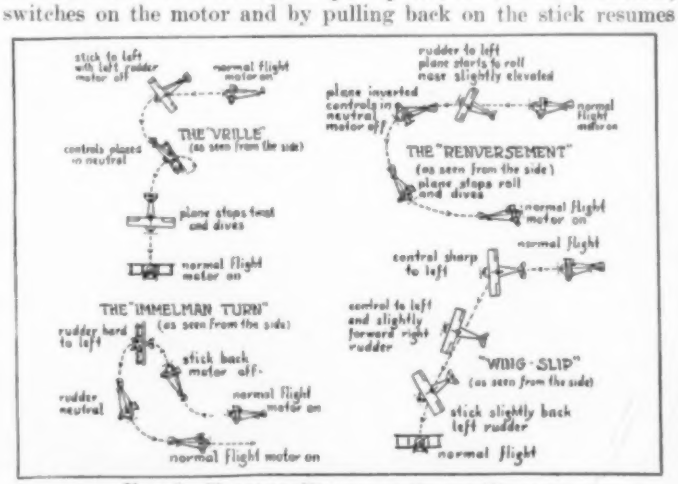


Fig. 1 Various Forms of Stunt Flying

When done properly the turn is a very pretty performance and no loss of altitude results. It can be performed to either side with uniform results, and after the pilot is thoroughly accustomed to the movement he may use his motor throughout the complete evolution with no loss of speed.

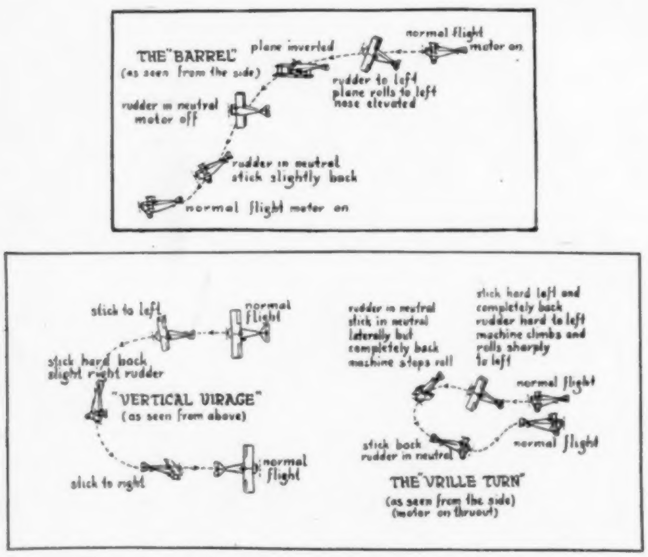
The Barrel. The "barrel" might also be called a horizontal vrille and it is performed exactly the same as the renversement, with the exception that the controls are not placed in neutral when the machine is upside-down, just before the machine again reaches normal line of flight. The first movements of the machine are identically the same as when in a renversement, but the roll continues until the plane has made one roll of 360 deg. at which time the motor is switched on and normal flight resumed.

The Vertical Virage. The vertical virage is nothing more or less than a turn in which the plane is banked until the wings are perpendicular to the ground and elevators are used for turning. It is used to turn quickly into the opposite direction without loss of either speed or altitude.

Flying level at full speed the necessity to turn suddenly is met by throwing the control stick to the side on which the turn is desired and accompanying it with a little corresponding rudder. When the position is reached in which the wings are perpendicular to the ground the stick should be placed in neutral and pulled hard back. The movement should be accompanied by opposite rudder sufficient to keep the nose of the machine from falling.

As a result of the above movements the machine banks sharply and as the stick is pulled back it seems to spin around, using the tip of the low wing as a pivot. As soon as the desired amount of turn has been made the pilot places his stick to the opposite side from which the machine is banked and the plane levels out and resumes normal flight.

The Side-Slip. Since the side-slip allows the pilot to lose an



Figs. 2 and 3 Various Forms of Stunt Flying

abnormal amount of altitude in proportion to the distance progressed forward, it is a very useful stunt. A pilot in making a forced landing may allow himself to overshoot his landing field and then side-slip off any surplus altitude, thus assuring his reaching the field.

In aerial combat and in dodging anti-aircraft fire it is also very useful, as it is a method of losing altitude very rapidly, and since in a side-slip the direction of motion is not directly forward it is very disconcerting to an enemy firing at the machine.

A side-slip is accomplished by pushing the control stick all the way to one side and accompanying it by sufficient pressure of the opposite foot to hold the nose of the machine up. The control stick is at the same time pushed slightly forward and the machine descends sidewise at a terrific speed.

To recover from a side-slip the control stick is placed in neutral and the rudder corresponding to the direction of the slip is pushed. As a result the machine turns and dives into the direction of the slip and by redressing the stick straight-away flight is resumed.

The Vrille Turn. The vrille turn is very similar to the renversement, but, unlike the latter, it is very useful in air combat. It is performed with full motor and is a very rapid evolution.

The stick is pulled quickly all the way back and completely to the side, accompanied by a sharp kick of the rudder to the left. As a result the nose of the machine jerks up and the plane rolls to the left.

The rudder is immediately placed in neutral and the stick is brought back to the center but held completely redressed. The neutralizing of the rudder stops the roll and as the stick is held completely redressed the nose of the machine immediately climbs to level and normal flight is resumed. No loss of altitude results.

As the motor is used throughout the turn the motions are necessarily very rapid and rather disconcerting when first attempted, but one soon becomes accustomed to the rapidity of the twist.

The Loop. The loop is accomplished by putting the nose of the machine down slightly to obtain maximum speed and then pulling back on the control stick, slowly at first and more rapidly as the top of the loop is reached. Just after the top has been passed the motor should be cut, the machine being allowed to fall of its own momentum through the last half. When the loop is completed the stick should be placed in neutral, the motor switched on and normal flight resumed. When looping with a plane using a rotary motor some left rudder should be used at the top of the loop to prevent falling out of the loop to the right.

A loop improperly done may result in a vrille, and taken as a whole looping is of no value in a fight, for while a machine is inverted the pilot is quite helpless until the machine has passed the "dead point" and started downward, thus giving an enemy who is following a good target. The machine-gun belt is likely to become disarranged and cause the gun to jam.

If the loop is improperly done the reversals of pressure are very severe and are extremely hard on a finely adjusted and very fast machine, but a loop properly done causes very little strain.

The Tail-Slide. A real tail-slide should not be accomplished with a machine using either ailerons or wing flaps for lateral control, because when it is properly done the reversal of pressure may cause them to buckle.

A tail-slide should never be attempted by even the most experienced pilot unless he has an especially built exhibition plane, preferably a monoplane, which is equipped with warping wings and is constructed strong enough to withstand the tremendous reversal of pressure.

A stall accompanied by a slight drop of the tail, followed by a slipping off to the side into a vrille, cannot be called a tail-slide, for a well-performed tail-slide will extend for at least 300 meters.

The Time and Place for Acrobacy. Aerobacy at low altitudes is strictly forbidden at training schools and it should never be done close to the earth except in cases of emergency and actual combat.

A pilot cannot at all times be sure of the condition of the

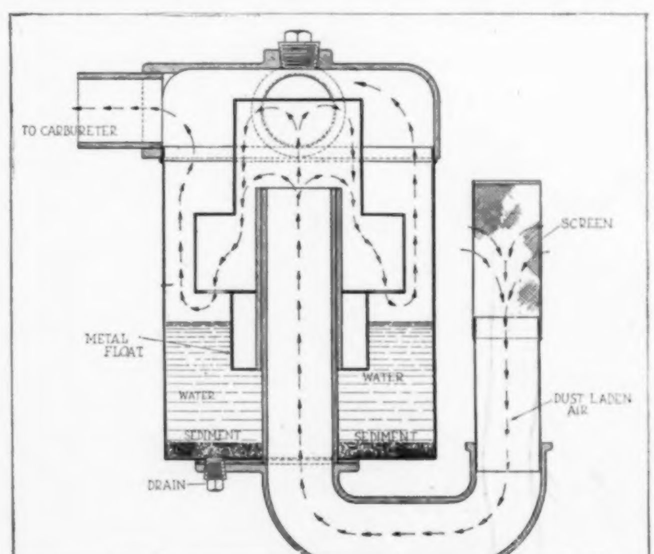


Fig. 4 Liquid Air Cleaner

atmosphere which he cannot see and fatal falls often result when overconfidence meets with bad air conditions near the ground. (*Aerial Age Weekly*, vol. 8, no. 8, November 4, 1918, pp. 422-423, 3 figs., *dA*)

Air Machinery

Air Cleaners, W. G. Clark. Analysis and comparison of various air cleaners such as used for washing the air on tractor engines.

The writer divides all cleaners now in use on tractors and trucks into four types: (1) cloth or screen type; (2) inertia cleaners; (3) liquid-type cleaners where water or some other liquid is used to wash the air, and (4) centrifugal or gravity

cleaners. The various types are briefly described and illustrated.

The disadvantage of the cloth- or screen-type cleaners lies in their being difficult to handle, ineffective and bulky. They must be very large in order to cut down the air velocity. The cloth or screen soon clogs and restricts the flow of air to the carburetor.

The action of inertia cleaners depends on the inertia of the dust in the air to carry it out of the air stream when the air flow is suddenly reversed or changed before passing to the carburetor.

The third type comprises those cleaners in which the liquid is employed to trap the dust. One such cleaner is shown in Fig. 4. It is said that this cleaner has the objection of employing a floating member with a large bearing surface exposed to the wearing action of the dust entering the cleaner.

Several types of centrifugal cleaners are described and illustrated.

The writer claims that the efficiency of the liquid and gravity types is approximately the same, but that the former may have an advantage in that the water entering by the air aids in the process of carburetion. (Paper presented at a recent meeting of the Minneapolis Section of the Society of Automotive Engineers, abstracted through ***Automotive Industries***, vol. 39, no. 16, October 17, 1918, pp. 678-680 and 696, 8 figs., *cd*)

Fuel and Firing

FUEL TESTS IN NORTHERN SASKATCHEWAN. A series of tests was conducted at the Prince Albert Power Plant, Alberta, Saskatchewan, to determine the relative values of various fuels available locally.

The fuels tested were bituminous and lignite coals from the Province of Alberta, jack pine and poplar cordwood, spruce edgings, planing-mill shavings and hog fuel. The tests were carried out on a hand-fired 72-in. return tubular boiler 18 ft. long, normal rating 150 hp. The grates used were one-half herringbone pattern, having a total grate area of 36 sq. ft., with air spaces forming approximately 45 per cent of the total area.

TABLE 1. RESULTS OF TESTS WITH SASKATCHEWAN FUELS

	Bituminous Slack	Lignite 50 Per cent Nut 50 Per cent Slack	Jack Pine Cordwood	Poplar Cordwood	Spruce Edgings
Duration of test, hr.	6	6	6	6	6
Gage pressure, lb.	125	125	125	125	125
Average temperature feedwater, deg. fahr.	177	179	180	180	178
Average temperature flue gases, deg. fahr.	490	495	500	485	490
Thickness of fire, in.	9	4	24	24	24
Draft, in.	0.12 to 0.19	0.04 to 0.27	0.01 to 0.02	....	0.00 to 0.01
Total water evaporation, lb.	24,200	22,800	23,600	24,000	24,400
Total fuel fired, lb.	2,600	4,100	5,565	6,830	8,022
Total fuel fired, cords of 128 cu. ft.	....	....	2.1	2.75	3.6
Total weight ash and clinker, lb.	314	374	37	57	108
Per cent ash and clinker	12	9	0.65	0.85	1.35
Water evap. per lb. of fuel as fired, lb.	9.3	5.6	4.3	3.5	3.0
Equivalent evaporation from and at 212 deg. fahr. per lb. of fuel	10.0	6.0	4.6	3.8	3.3
Equivalent evaporation from and at 212 deg. fahr. per cord of 128 cu. ft.	....	....	12,100	9,100	7,300

In tests with some of the lignites the fires were not cleaned, the boiler operating, roughly, not higher than at 80 per cent of its rated capacity. With other fuels the fires were cleaned about every two and a half hours. A fuel bed about 4 in. in thickness was found most suitable, and the best results were obtained when the clinker was left undisturbed; no slice bar being used. In fact, the use of the bar seemed to increase the amount of clinker even when the greatest care was exercised. This applies apparently especially to the case of burning lignite slag.

In the tests with wood the same herringbone grates were used as for coal, but the ends next to the bridge wall for a distance of 18 in. were covered with sheet iron protected by a layer of ashes. A poker was used occasionally to consolidate the fuel, and the furnace was kept as full as possible.

The quantity of ash with wood was very low, and the grates did not require any cleaning at all. It is stated that the firemen experienced in handling cordwood claimed it much easier work than firing coal. The results of the tests are given in Table 1. (*Power*, vol. 48, no. 18, October 29, 1918, pp. 624-625, *e*)

Heating and Ventilation

A VENTILATION PARADOX, Thos. R. Wilson. Description of air conditions in the Chicago freight tunnel.

The enormous quantities of various materials through which the tunnel is driven (including water) act as a great reservoir of heat, extracting heat from the tunnel air when the latter is warmer than the tunnel surface. During cold weather the opposite flow of heat takes place, the heat stored in the materials about the tunnel being given back to the air through the millions of square feet of tunnel surface. These conditions balance so accurately that the entire temperature variation throughout the year in the tunnel air is less than 10 deg.

This had a rather unusual result. In the summer months air is almost always in a saturated condition as the outside air is cooled to the dewpoint. This keeps the tunnel air practically free from dust, partly because the condensation of moisture on the dust particles causes their precipitation to the tunnel invert.

In the summer of 1916 a complaint was received respecting the use of tunnel air in a cold-meat storage room of a certain downtown hotel, the claim being made that such air is unsanitary. Various tests for air purity were made and revealed a remarkable freedom of the air from dust. (*Heating and Ventilating Magazine*, vol. 15, no. 10, October 1918, pp. 42 to 45, 4 figs., *d*)

Hydraulics

HYDRAULIC TESTS OF A 715-HP. HIGH-SPEED WATER TURBINE OF SWISS CONSTRUCTION, W. Schmid. Description of tests of a turbine built by Escher, Wyss & Company, of Zurich, Switzerland, and tested in 1917, after installation in the new hydroelectric plant at Thun.

The general construction of the turbine and its installation are apparent from Figs. 5 and 6. The tests were based on the following guarantees of the contract: Net hydraulic head $H = 5$ to 6.1 m. (16.4 to 20 ft.); water discharge $Q = 10{,}300$ to 11,000 l. per sec. (2720 to 2905 gal. per sec.); output N_e is 545 to 715 hp.; speed n 150 r.p.m.; efficiency η at 715 hp. 79 per cent, at 625 hp. 80 per cent, at 535 hp. 77 per cent, and at 447 hp. 73 per cent, with a tolerance of 2 per cent either way. The greatest permissible rise in speed over the respective speeds in the case of sudden removal of load was specified as 3, 6 and 15 per cent, respectively, for loads of 178.7, 357.5 and 715 hp. These contract values correspond to a specific speed of rotation of

$$n_s = \frac{n}{H}\sqrt{\frac{N}{\sqrt{H}}} = \frac{150}{6.1}\sqrt{\frac{715}{\sqrt{6.1}}} = 418$$

As regards the construction of the turbine, Fig. 6 is of particular interest as it indicates the new form of rotor with its large space between the Fink regulating buckets and the rotor buckets proper.

The ventilating pipes open into this intervening space and remain open during operation of the turbine (and also were kept open during the test runs described in the present article), the access of internal air being also allowed freely. This arrangement has been patented and is designed to improve the efficiency at partial load.

The oil-pressure governor of the type generally used by the company is installed here.

The actual tests were carried out on December 9, 1917, and only certain test points in the efficiency curve of the turbine were selected to be established: namely, a point near the peak of the output of the turbine, and about 447 hp.

At the beginning of the first continuous run it was found that

with the turbine under full load it was difficult to maintain constant conditions in the water flow and the gate was reduced to 90 per cent. Thereafter, five tests were carried out in the following order:

1 A two-and-a-quarter-hour run with the turbine gate open 90 per cent for the purpose of determining the efficiency of the turbine.
2 Run with the gate open 100 per cent to determine the maximum output of the turbine.
3 Load on the generator changed from full-load to no-load to determine the rise in potential.
4 A two-hour run with the turbine gate open 72 per cent to determine the efficiency of the turbine at that position.

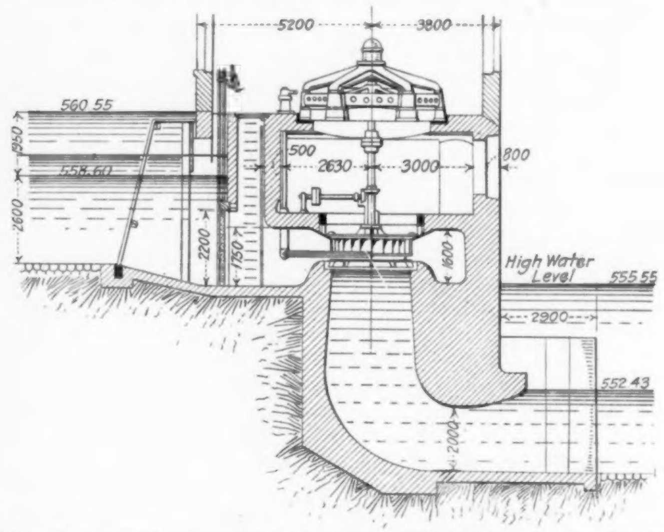


FIG. 5 SECTION THROUGH THE NEW ENGINE ROOM OF THE HYDRO-ELECTRIC PLANT AT THUN (SCALE 1 TO 200)

5 Test of the governor control, consisting of observation of increase in speed with change of load on the generator and turbine from full load to no-load.

EFFICIENCY OF THE TURBINE

In Fig. 7 curve A indicates the efficiency of the turbine as a function of the output, on the basis of the guarantees of the builder of the turbine. The two points indicated by the present tests and indicated in that figure have been found by the following calculations:

For an opening of the turbine gate of 90 per cent, the volume of water Q delivered to the turbine was 10.113 cu. m. (357.02 cu. ft.) per sec. and the average actual head 6.067 m. (19.903 ft.). Hence, the available output was

$$N_a = \frac{Q.H.\gamma}{75} = 818.07 \text{ hp.}$$

On the other hand, the output measured at the generator with instruments of high precision and a water rheostat was

$$N = 463.6 \text{ kw.} = 629.89 \text{ hp.}$$

Hence, the overall efficiency of the turbine and generator was

$$\eta_{tot} = \frac{629.89}{818.07}\, 100 = 76.997 \sim 77 \text{ per cent}$$

But from an efficiency curve of the generator reproduced in the original article, it appears that at a total output of 463.6 kw. it has a total efficiency of 92.5 per cent, which shows that the efficiency of the turbine alone is

$$\eta_T = \frac{77}{0.925} = 83.24 \text{ per cent}$$

and the output of the turbine

$$N_e = \frac{629.89}{0.925} = 680.96 \text{ hp.}$$

With a gate opening of 72 per cent, the volume of water discharged by the turbine was $Q = 6.981$ cu. m. (246.48 cu. ft.) per sec. and the actual average head 6.195 m. (20.324 ft.) which gave an available output of power of $N_a = 576.63$ hp. The power output measured at the generator was $N = 304.15$ kw. $= 413.25$ hp., which gave an overall efficiency of

$$\eta_{tot} = \frac{413.25}{576.63}\, 100 = 71.66 \text{ per cent}$$

At that output the efficiency of the generator was found to be 90 per cent, which indicates an efficiency for the turbine alone of

$$\eta_T = \frac{71.66}{0.902} = 79.45 \text{ per cent}$$

and shows that the output of the turbine was

$$N_e = \frac{413.25}{0.902} = 458.15 \text{ hp.}$$

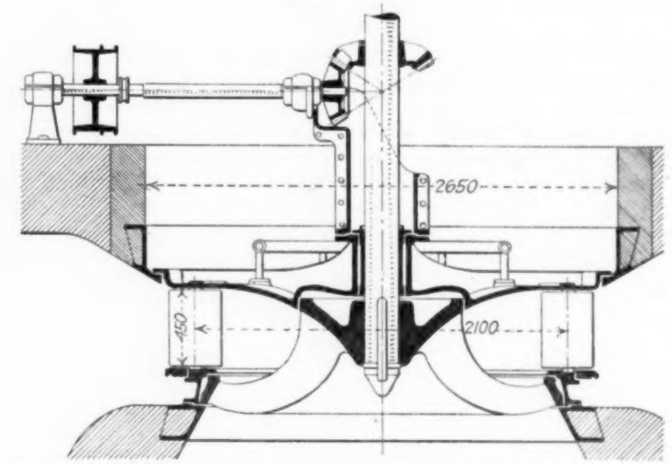


FIG. 6 SECTION THROUGH THE HIGH-SPEED 715-HP. SWISS WATER TURBINE (SCALE 1 TO 40)

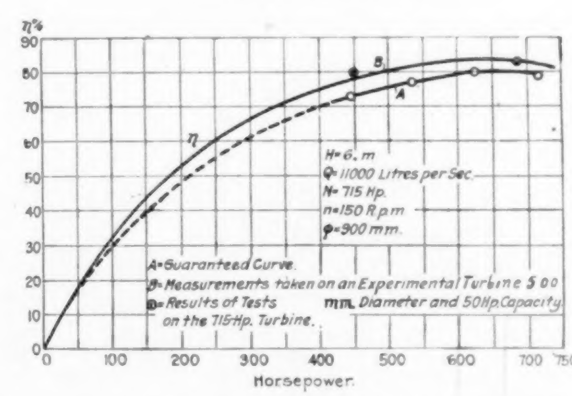


FIG. 7 EFFICIENCY CURVES OF THE HIGH-SPEED TURBINE SHOWN IN FIG. 6

While these two points do not in themselves completely determine the efficiency curve of the turbine, they permit plotting it with a fair degree of approximation when the data of similar tests on other apparatus are taken into consideration. In particular, since the two control points determined by actual tests lie considerably above the guarantee curve, it is reasonable to assume that the entire performance curve is above the guarantee curve.

The values thus found are in fairly good accord with the curve B in Fig. 7, which expresses the conditions in the turbine under test. It is also stated that the measurements were sufficiently precise for all practical purposes.

MAXIMUM OUTPUT OF THE TURBINE

In test 2 with the turbine gate wide open the output as measured by the generator was found to be $N = 495.9$ kw. At this output the efficiency of the generator is 0.926 and the total output of the turbine is

$$N_{e\ max} = \frac{495.9}{0.736 \times 0.926} = 727.6 \text{ hp.}$$

However, during this test the head was only $H = 6.014$ m. (19.730

ft.), and was, therefore, less than the head specified by the builders of the turbine, or $H = 6.10$ m. (20.003 ft.). When the head varies slightly while the opening of the gate remains the same, the output of the turbine varies in accordance with

$$N_1 = N_0 \cdot \sqrt{\left(\frac{H_1}{H_0}\right)^3}$$

so that with the normal head $H_1 = 6.1$ m. (20.003 ft.) the maximum output would have been

$$N_1 = 727.6 \cdot \sqrt{\left(\frac{6.100}{6.014}\right)^3} = 743.3 \text{ hp.}$$

As a matter of fact, the guaranteed output was $N_e = 715$ hp. at a head of 6.1 m. (20.003 ft.) and an efficiency of 79 per cent, so that the actual performance was about 4 per cent better than the guaranteed performance.

During the test with the gate open 90 per cent, it was found that at maximum output the efficiency of the turbine is about 3 per cent higher than the guaranteed value, and from Fig. 7 it appears that at maximum output the efficiency is around 82.2 per cent. Hence, even if the turbine should take only as much water as was provided for in the designs of the builders, its maximum output would have been still around 743.9 hp., and the agreement of this value with the one calculated above shows the precision of the test with the 90 per cent gate.

To the maximum output corresponds a specific speed of

$$n_s = \frac{n}{H} \cdot \sqrt{\frac{N_{max}}{\sqrt{H}}} = \frac{150}{6.1} \cdot \sqrt{\frac{743}{\sqrt{6.1}}} \sim 427$$

Capacity for Governing

When the load was suddenly thrown off and thus reduced from 480.1 kw. or 705 hp. to zero, the periodicity, as indicated from the frequency meter, changed from 50 to 56 cycles. Considering that within 10 sec. a constant state of 52 cycles was reached, this indicates a rise of

$$\frac{56-52}{52} \times 100 = 7.69\% \sim 8 \text{ per cent}$$

This amount is only a little in excess of one-half of the guaranteed maximum of 15 per cent.

These tests show how closely a large Francis-type turbine of modern construction can hold within guaranteed limits. The speed of 427 r.p.m. is to be considered as being very high, but is of advantage as it reduces materially the first cost of the plant. Also, notwithstanding this high speed, the efficiency of 79.45 per cent at five-eighths load is also very good and indicates that this new type permits utilizing very well the available water heads, even at partial load.

It is true that with the new type the efficiency on loads under half of the maximum decreases more rapidly than with the former standard types. This, however, is claimed to be compensated for by advantages in other directions. (*Schweizerische Bauzeitung*, vol. 72, no. 14, October 5, 1918, pp. 129-131, 4 figs., *eA*)

A Proposed Hydraulic Experiment, Lord Rayleigh. Stokes showed in 1850 that in the case of a homogeneous incompressible fluid whenever $udx + vdy + wdz$ is an exact differential, not only are the ordinary equations of fluid motion satisfied but the equations obtained when friction is taken into account are satisfied likewise. It is only the equations of condition which belong to the boundaries of the fluid that are violated.

In order to satisfy these conditions also it is only necessary to suppose that every part of the solid boundaries is made to move with the velocity which the fluid would there assume in irrotational motion.

The only way, however, to carry this into effect with tolerable completeness is by the two-dimensional motion of fluid between co-axial cylinders, which themselves are rotating in the same direction with the circumferential velocities which are inversely as the radii. Experiments upon these lines which are believed to have only partly satisfied the above conditions have been made by Conette and Mallock.

But the point of greatest interest is not touched in the above arrangement. It arises when a fluid passing along a uniform or contracting pipe or channel arrives at the place where the pipe expands. If the expansion is sufficiently gradual the fluid, generally speaking, follows the walls, or, as it is often expressed, the pipe flows *full* and the loss of velocity accompanying the increase in section is represented by an augmentation of pressure approximately according to Bernouilli's law.

On the other hand, if the expansion is made violently, the fluid refuses to follow the walls; eddies result and mechanical energy is lost by fluid friction.

According to W. Froude this is due to loss of velocity near the walls in consequence of fluid friction, which is such that the fluid in question is unable to penetrate into what should be the region of the higher pressure beyond.

The writer proposes a comparatively simple experiment, which, while not fully satisfying all conditions, might throw interesting light upon the subject. It is proposed to observe the flow of liquid between two cylinders A and B, Fig. 8 (probably brass

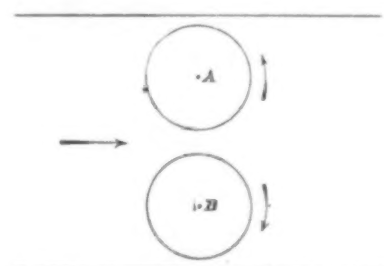


Fig. 8 Diagram of Lord Rayleigh's Proposed Hydraulic Experiment

tubes) revolving about their axes in opposite directions. The circumferential velocity of the cylinders should not be less than that of irrotational fluid in contact with the walls at the narrowest place. The simple motion may be unstable, but the critical situation would be so quickly traversed that possibly the instability may be of little consequence. If no marked difference in the character of the flow could be detected by color streaks whether the cylinders were turning or not, the inference would be that Froude's explanation is inadequate. In the contrary event, the question would arise whether particular advantage could be taken by specially stimulating the motion of the fluid near the walls of expanding channels, as, for example, with the aid of steam jets. (*The London, Edinburgh & Dublin Philosophical Magazine*, vol. 36, no. 214, October 1918, pp. 315-316, 1 fig., *t*)

Internal-Combustion Engineering

Investigation of the Governing of a Gas Engine, Prof. A. Gramberg. The governing of a gas engine by throttling the mixture as shown diagrammatically in Fig. 9, differs fundamentally from the governing of a steam engine as described by the present author in another article. (See abstract in The Journal, November 1918, p. 967).

The governing of any power-producing engine is affected by the variation of the load on the engine. If the power-producing engine is a gas-engine generator set, as in the present instance, then the resistance W_A of the external circuit may be varied by introducing new resistances in parallel with the initial resistances. At the beginning of the no-load run the resistance of the external circuit is infinitely large, a fact which cannot conveniently be indicated diagrammatically. For this latter purpose, instead of the resistance it is more convenient to use the reciprocal of it $\frac{1}{W_A}$, or the conductance of the external circuit which at no load is equal to zero. In that case one measures the potential at the terminals of the generator in volts E and the current J.

With the increase in conductance, J and hence the output $N_{EL} = E\,J$ increase, and, therefore, the speed N in r.p.m. decreases.

The decrease of speed has as its consequence the decrease of the electromotive force of the generator with the increase of load, this electromotive force being proportional to the speed of rotation. The potential at the terminals decreases still more since the loss of potential in the armature of the dynamo increases with the current. The decrease of the terminal voltage E due to these two influences has to be equalized by manipulating the field rheostat and also by increasing the exciting current. This may continue until the field rheostat is entirely short-circuited and the exciter winding is connected directly to the terminals. The exciting current in the generator under consideration may reach the maximum value $i_{max} = 1.05$ amperes at the terminal voltage of 220 volts.

The results of the tests are given in Figs. 10 and 11 and Table 2. In the first three tests, Nos. 89, 90 and 91, the transition was made in two broad steps from no load to full load and the

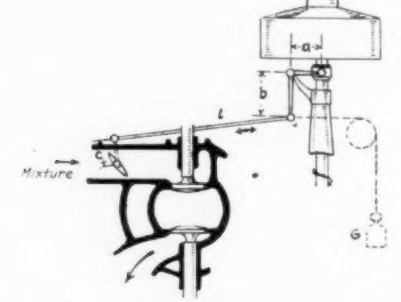


FIG. 9 DIAGRAM OF THE GOVERNOR ARRANGEMENT ON A GAS ENGINE

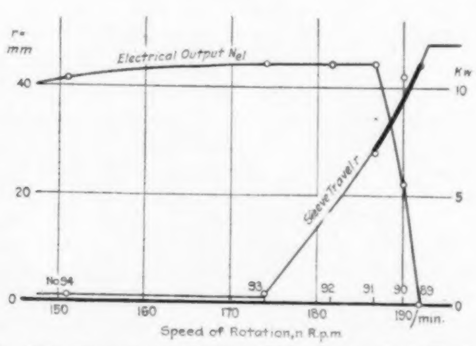


FIG. 10 GOVERNOR CURVES TAKEN ON GAS ENGINE

rheostat had to be adjusted from contact point 3 to contact point 20 in order to maintain the potential, although the speed fell off from 192.0 to 186.7 r.p.m.

In the next test, No. 92, the external conductance was raised only a little, viz., from 0.227 to 0.235 A_V, but although the rheostat was shifted previously the maximum output was exceeded. When in test No. 93 the rheostat was shifted from contact point 22 to 25, the desired potential could not be obtained. The governor went down and with it the speed of rotation, which brought the potential lower than the field rheostat was capable of handling.

If, finally, in tests 94 to 96 we set the field rheostat at its ultimate contact point 41 and then raise the conductance still more, we only succeed in reducing the speed, as the engine is then overloaded.

A peculiar feature of this whole phenomenon as compared with that of steam-engine governing is that only a small part of the stroke of the governor sleeve is utilized, viz., the heavy line in Fig. 10. At 192.0 r.p.m. the engine runs at no load and already at 186.7 r.p.m. the maximum load is reached while the governor is still 28 mm. above its lowermost position. Nevertheless, the further sinking of the governor does not produce any increase in load.

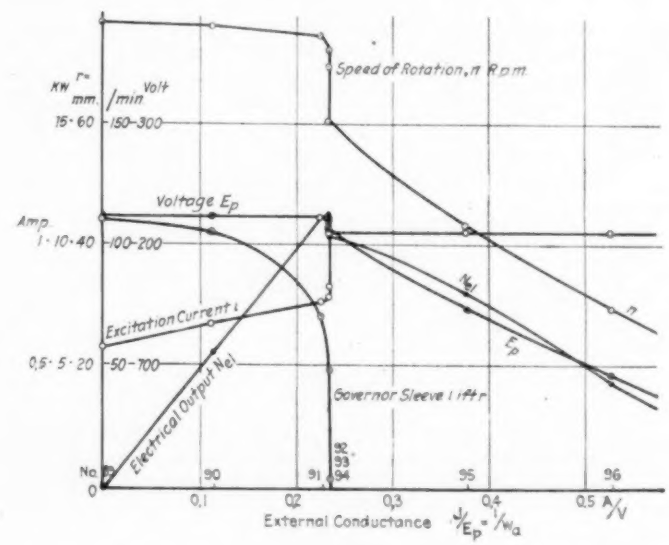


FIG. 11 CURVES OF OPERATION OF AN AUTOMATICALLY GOVERNED GAS-ENGINE GENERATOR SET

These facts represent the external appearance of the phenomenon; the inner reason wherefore the possible rise cannot exceed $\frac{1}{W_A} = 0.235$ is due to the transformation of energy. Up to test No. 91 the volumetric efficiency η_{vol} (as read from the indicator diagram) increases. In experiment 91 the volumetric efficiency is seen to be 0.985 and therefore cannot be materially increased. With the governor position $r = 28$ mm. above the lowermost position the throttle valve has already opened so far that the mixture does not meet with any material resistance, and the further opening of the throttle valve cannot produce any change in conditions. Hence, the further movement of the

TABLE 2 BEHAVIOR OF GAS ENGINE GOVERNING AT OVERLOAD (EXTERNAL EXCITATION ON DYNAMO)

No. of test	89	90	91	92	93	94	95	96
External conductance, $J/E_p = 1/W_a$ .... A/V	0	0.113	0.227	0.235	0.235	0.235	0.377	0.528
Field rheostat position k .... Contact No.	3	12	20	22	23	41	41	41
Exciter current i .... A	0.57	0.67	0.76	0.78	0.82	1.05	1.05	1.05
Potential at terminals E_p V	222	222	221	217	216	212	146	90
Electrical output, $N_{el} = E_p J$ .... kw.	0	5.55	11.1	11.1	11.2	10.4	8.03	4.27
Speed of rotation, n .... r.p.m.	192.0	190.1	186.7	181.7	174.1	151.0	107.8	73.6
Position of governor, r .... mm.	44	42	28	17.5	1.5	1	1	1
Volumetric efficiency, η_V	0.595	0.745	0.985	0.985	0.985	0.995	1	1
Mixture ratio, L/G_o .... $m^3\left(\frac{0}{760}\right)$ per hr.	12.0	10.4	9.3	9.3	9.25	9.2	9.35	10.7
Gas consumption, $G/_o$	4.92	7.13	10.28	10.13	9.79	8.63	6.19	3.5
Coefficient of output, η_i	0.44	0.57	0.76	0.77	0.78	0.78	0.79	0.7
Timing of ignition, from dead center .... deg.	−16.5	−10	−4	−5	−6	−11	−9	−17.5
Indicated pressure, p_i .... atmospheres	2.07	3.41	4.84	5.16	5.11	5.39	5.28	4.51
Exhaust gas temperature, t_e .... deg. cent.	348	374	419	422	420	396	354	288

governor is without effect: If the amount of fuel mixture introduced cannot be increased, a further supply of energy is made impossible.

Hence, in this instance, contrary to what happens in the case of the steam engine, the maximum output of the engine is governed not only by the governor and its appurtenances but by the engine itself.

Judging by Fig. 10 the governor is strongly static. It has a degree of lack of uniformity equal to

$$\frac{192.0 - 174.1}{\frac{1}{2} \cdot (192.0 + 174.1} = 0.098$$

or 9.8 per cent. On the other hand, the governing itself is much less static, because it does not utilize the full range of the governor. Its coefficient of lack of uniformity is

$$\frac{192.0 - 186.7}{\frac{1}{2} \cdot (192.0 + 186.7)} = 0.028$$

or 2.8 per cent. It is therefore necessary to distinguish in this case the properties of governing from those of the governor.

One might presume that the governing, being practically astatic, would be subject to violent oscillations. This is not the case, however. Fig. 12 gives the tacho-diagram of the governing, which seems to be quite satisfactory, although at full load and no load the current interrupter was brought into play.

Lubrication

THE VISCOSITY OF LUBRICATING OILS, E. Oelschläger. (*Zeits. Vereines Deutsch. Ing.*, 62. pp. 422-427, July 6, 1918). The author, in this portion of his extended series of articles upon lubricating oils, deals with the relation between viscosity and temperature. He points out that it is customary to carry out the viscosity test at various temperatures according to the intended application of the oil, the usual test temperature for transformer oils being 80 deg. cent., and for bearing oils 50 deg. cent., and for cylinder oils 100 deg. cent. No formula or chart, however, has existed up to the present which would enable one to calculate the viscosity at any other temperature than that at which the observation was actually made.

As a result of an extended investigation of the results obtained with many oils, the author has constructed curve diagrams which overcome this difficulty. By aid of these, the viscosity of any oil can be ascertained for any temperature when one determination of it has been made. The only exceptions to the law governing the rate of change in the viscosity with temperature variations, are rape-seed oil, linseed oil, and blubber oil. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, pp. 320-321, *eA*)

Machine Design (See also Internal-Combustion Engineering)

EFFICIENCY OF THE SCREW, Benjamin F. Groat, Mem.Am.Soc. M.E. An important article, for a complete abstract of which, unfortunately, there is not enough available space. It embodies an attempt to express in mathematical formulae the performance of various types of screws, so that a screw of given efficiency can be constructed from arbitrary dimensions.

Among other things, the writer tries to show that the torque upon a screw necessary to lift a given load cannot be determined by the use of a general coefficient and that each design has its own coefficient.

A screw is defined from the mechanical point of view as a machine which converts a torque into a thrust, or, inversely, a thrust into a torque. It acts as an intermediary between three external bodies, one of which may be considered to be a fulcrum and to be at rest. The mutual interactions between the other two bodies and the screw may then be considered under three different headings.

Case 1 (Fig. 13). The screw receives a torque from one of the bodies and converts a portion of that torque into an equivalent thrust, which it transmits to the other body. A jackscrew lifting a weight is an example of this case.

In Fig. 13 it should be understood that the nut is fixed while the screw turns and that θ = angle BPC and ϕ = angle CPA, which are respectively the angles of slope of threads and of friction.

In case 2 (Fig. 14) the screw receives a thrust from one of the bodies and converts a portion of that thrust into an equivalent torque, which it transmits to the other body. A "spiral" ratchet screwdriver affords one of the few examples of this case. The slope of the screw threads must exceed a certain minimum. Fig. 14 is generally similar to that of Fig. 13, but the angle of slope $\theta = BPC$ is numerically greater than the angle of friction $\phi = CPA$, and of contrary sense. There is a component AB of the resultant AP which *assists* the motion, and the motion must occur unless opposed by a torque upon the screw of sense contrary to the impending motion and to the component AB. A limit of this case is reached when $\phi = -\theta$, that is, when A falls upon B, which

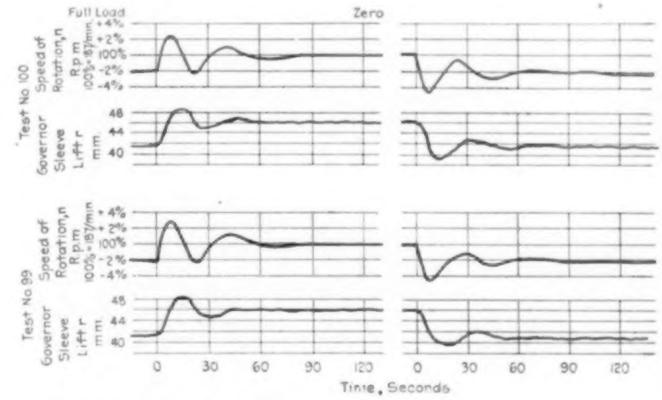


FIG. 12 TACHO-DIAGRAMS OF AN AUTOMATICALLY GOVERNED GAS-ENGINE GENERATOR SET

implies that the screw locks and cannot turn unless assisted by an external torque.

Case 3 (Fig. 15). Here the screw receives a torque from one of the bodies and a thrust from the other, the combined work of both torque and thrust being consumed in friction. A jackscrew letting a weight down is an example of this case. The slope of the screw threads cannot exceed a certain maximum. In this case the point A falls to the left of B. The motion cannot occur unless assisted by an external torque upon the screw of the same sense as the motion, but, as in all cases, contrary to the component AB, which may be taken as a measure of the couple that must exist in the screw spindle in order to maintain uniform rotation; it should be remembered, however, that bearing friction is an additional element not yet taken into consideration.

The notation employed is as follows:

T = the thrust which is due to the reaction between the threads of the screw and the threads of the nut. It is not necessarily equal to the thrust delivered by the screw upon external bodies, considering the screw, nut and thrust bearing to be a self-contained unit. This is because the weights of parts of the screw may affect the action.

t = the thrust upon the thrust bearing. It is not necessarily equal to T, though, where the weights of the affecting parts of the screw are negligible, it is usually so considered. The relative values of T and t thus depend in each case upon the particular positions of the screw and the bodies acted upon.

M_t = the torque which is theoretically equivalent to the thrust, T, due to the reaction between the threads.

M = the actual torque passing between the screw or nut, as the case may be, and the body which receives or imparts torque.

M_s = the torque which exists in the body of the screw or of the nut, according as it is the screw or the nut which turns.

The writer calls attention to certain relations which may exist between M_t, M and M_s.

μ and ϕ are, respectively, the coefficient and angle of sliding friction for the threads. When thrust is being converted into torque (the weight descends) these quantities are both to be taken negative in the general formulæ. "It appears that for screws lubricated with oil, with pressures of $1\frac{1}{2}$ to 5 tons per square inch of projected area of screw thread, and for low speeds, the

coefficient is about 0.11 to 0.20 whether the screw or the nut are of steel, wrought iron, cast iron or bronze."—Unwin.

μ_1 and ϕ_1 are, respectively, the coefficient and angle of friction for the thrust bearing. They are probably somewhat less than the corresponding values for the threads. If the threads are not cut threads they may be considerably less. They are both negative in the general formulæ when the weight descends.

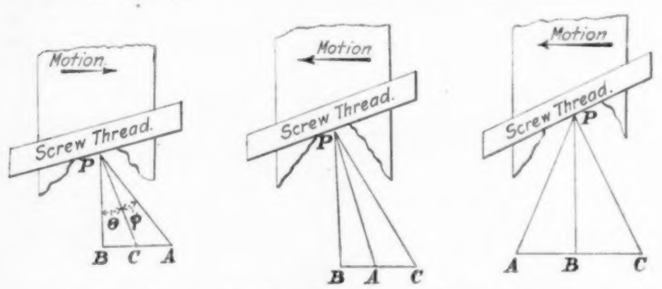
r = average radius of the screw threads or arm of frictional resistance acting upon the surface of the threads. No great error will be made if it is taken as the arithmetical mean of the inner and outer radii of the screw threads. If questions of elasticity are introduced, its exact determination becomes more difficult.

ρ = average radius (similar to that for r) of the pivot or collar.

n and θ are, respectively, the slope and the angle of inclination of the threads.

p = the axial pitch of the screw.

With the foregoing notation the following general formulæ concerning the square-threaded screw will be established:



FIGS. 13, 14 AND 15 THREE CASES OF SCREW OPERATION

$$M_t = \frac{Tp}{2\pi} = Trn \quad [1]$$

$$\frac{M_t}{M_s} = \frac{\tan\theta}{\tan(\theta+\phi)} \cdot = n\,\frac{1-\mu n}{m+\mu} \quad [2]$$

$$\frac{M_s}{M} = \frac{1}{1+KA}$$

where $n = \tan\theta = p \div 2\pi r = p \div 6.283r$; and μ, μ_1, ϕ and ϕ_1 are to be taken negative when the weight is being let down or the screw slackened. Also in accordance with formula [3]:

$$K = \frac{\tan\phi}{\tan(\phi+\theta)} \quad [4]$$

$$A = \frac{\mu_1}{\mu}\,\frac{t}{T}\,\frac{\rho}{r} \quad [5]$$

The formulæ for the maximum compound efficiency of screw and thrust bearings are given as follows:

$$n = -D + \sqrt{D^2 + (D \div \mu)}$$

where

$$D = \frac{\mu(1+A)}{1-A\mu^2}$$

and $n = \tan\theta$ and the above formula gives the critical value of n.

Two tables are included in the original article giving the values of $\frac{M_t}{M_s}$, $\frac{M_s}{M_t}$ and K directly as functions of n and μ, and several cases where these formulæ can be applied are discussed in considerable detail. In particular the case of the application of these formulæ to V-threads and worm gearing is given.

In this latter connection the writer agrees fully with the conclusions arrived at by F. A. Halsey (Mem.Am.Soc.M.E.) in the *American Machinist* for 1898. At the same time he points out that both velocity and friction are vectors, that is, directed magnitudes, and unless they act in the same line it is only the projection of one upon the other which is effective. Because of this the writer believes that the compound thread friction and tooth friction of the worm and wheel are to be added geometrically and not arithmetically. In other words, the compound friction is less than the arithmetical sum of the thread and tooth frictions. In practice, the method described by the writer gives slopes much larger than are usually employed for the threads of worms, and this must be done, as far as practicable, where maximum efficiency is required.

In addition to this, the side thrust between the worm and worm-wheel should be taken into consideration. The side thrust of the wheel may be eliminated by employing right- and left-hand wheels and two worms. With two more wheels and worms the friction losses in the step bearings may be eliminated by properly disposing the right- and left-hand worms and wheels in neutralizing pairs.

Finally an arrangement is described which eliminates side thrust upon the journal bearings of the wheels, making it unnecessary to use ball bearings. This arrangement consists of two wheel shafts, four wheels, four worm shafts and eight worms, the efficiency being that of threads only.

Highly interesting test data which cannot be abstracted on account of lack of space are presented in the appendices. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 34, no. 5, June 1918, pp. 377-429, illustrated, *pcA*)

Machine Shop

MANUFACTURE OF TRANSMISSION CHAIN, J. V. Hunter. Description of the plant and manufacturing processes of the Diamond Chain and Manufacturing Company of Indianapolis, Ind.

The company manufactures, in particular, a roller chain for drive between the various motors and lineshafts.

Part of the material used in the manufacture of roller chains comes in the form of rolled strips, but large quantities of round rod are used for pins and rollers, and figure-8-shaped cold rolled and drawn steel bars are used for block types of bicycle chains. Different grades of steel are used, depending on the part of the chain to be made, and also the service the chain must render. These grades vary from low-carbon dead-soft annealed steel to hard chrome-nickel steel.

An interesting operation, described in considerable detail, is the production of the side links. It is entirely a punching-machine

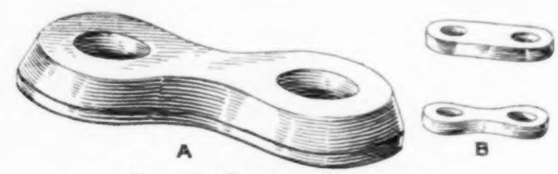


FIG. 16 TYPES OF SIDE LINKS

job. The types of the links are shown in Fig. 16, where A illustrates the larger sizes used for truck drive and power transmission and B the smaller sizes for bicycle chain, etc. In the larger sizes, as A, a noticeable feature is the beveled edge, which one can see in the figure. In assembling, this beveled edge is turned inward on the inside links where it comes in contact with the sprocket teeth to avoid the tendency to cut and wear, and outward on the outside links, adding to the finished appearance of the chain.

A Bliss punching machine with an automatic feed attachment for advancing the stock after each stroke of the punch is used in the manufacture of these side links.

In the smaller sizes the holes are punched for the center of each link end before the links are blanked from the strip. In the larger sizes the links are blanked first, then beveled and in the last operation the holes are punched and shaved. All holes are shaved as the necessary clearance allowance on the dies results in a slightly tapered hole. The hole is purposely made from 0.012 to 0.015 in. under size and the shaving leaves the hole about 0.003 in. under the diameter of the pin that will be driven into it later.

For trimming the many millions of side links which are used in the manufacture of a lighter type of chain an automatic device illustrated in the original article is used. The links are fed into long tubes which act as a magazine in feeding these pieces to the trimming machines. To do this the links are poured into the funnel-shaped magazine, which, by means of a belt drive, is rapidly jolted up and down. In the center of this funnel is a tube which is forced up and down through the blanks contained

in it. This tube has an open end of the size of the end of the blank, and the jolting action forces these blanks to enter it one at a time, after which they slide lengthwise to a special mechanism. There a small ram pusher forces the blanks forward and into line with the magazine tube, into which another small pusher crowds them until the tube has been filled throughout its length. An extensive use of this magazine-filling device is made throughout the plant. (*American Machinist*, vol. 49, no. 15, October 10, 1918, pp. 643-647, 13 figs., *d*)

GENERATING CAMS AND IRREGULAR-SHAPED WORK, Douglas T. Hamilton, Mem.Am.Soc.M.E. Discussion of the capabilities of the gear shaper for generating cams or other irregular forms on a commercial basis.

The writer claims that the production of cams on the gear shaper is not only a simple proposition but is also accurate and fast, and that it is possible with the gear shaper to obtain, in a commercial way, cams that are very difficult to produce accurately by tool-making methods.

As shown in Fig. 17 the cutter used in producing the cam does not have anywhere near the same appearance as the cam itself. Fig. 18 shows, diagrammatically, how this form of cutter generates the cam. In operation the cutter and the cam blank are rotated in unison with each other and the rolling is done on two imaginary circles which are identical with the pitch circles of two gears in mesh. As the cutter and cam blank roll around in mesh with each other, the outline is generated on the cam as is illustrated by the fine lines in Fig. 18, these indicating the various positions of the cutter as it is rolled in contact with the blank. In connection

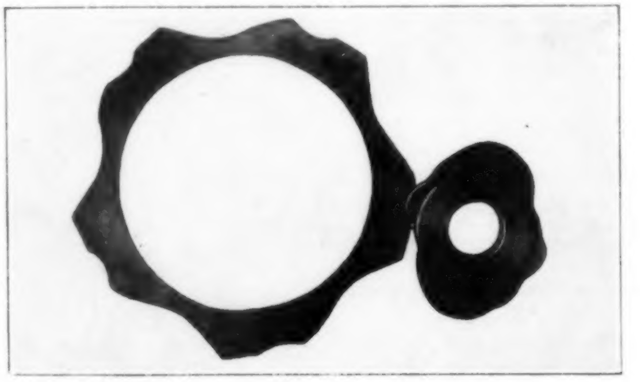


FIG. 17 EXHAUST CAM FOR GNOME ENGINE AND CUTTER USED IN PRODUCING IT

with this illustration, it is explained that the cutter has been rolled around the blank while the latter was stationary, this being done to simplify conditions and make the drawing clearer. In cutting these cam blanks a batch, preferably of eight blanks, is held in the fixture.

The article shows many interesting forms of cams, some of which would be very difficult to produce by milling, but are produced with comparative ease on the gear shaper. Among them is shown the breech block for a field gun upon which there is a series of interrupted gear teeth and a cam surface.

These examples are intended to show the successful application of the generating process, which is now used not only for cams proper but also for ratchets, milling cutters, etc., which were formerly produced by milling only. (*American Machinist*, vol. 49, no. 17, October 24, 1918, pp. 737-740, 12 figs., *pd*)

Machine Tools

SIMPLIFIED LATHE ADAPTED TO SHELL WORK. Description of the adaptation of the Gisholt 16 and 25 simplified lathes to munition work and of the various attachments used in that connection. An interesting feature of the new lathe is that, while it is made for a special purpose, the parts which enter into its several modifications have been standardized and reduced to a manufacturing basis.

The original article illustrates the machine in a rather interesting matter. First is shown what might be called a basic part: to wit, the bed, headstock, and parts always essential no matter for what operation the machine may be intended. Next is shown the machine equipped with a hand-operated collet chuck which may be mounted directly on the spindle nose close to the headstock in place of the faceplate and will accommodate work up to 6 in. in diameter. A carriage with a pillow-block support for the boring bar and center locking pin is also provided.

Then a semi-phantom view of the lathe is given. Shown in full size is the carriage with a 4-sided turret tool rest mounted on a right-angled compound cross-slide.

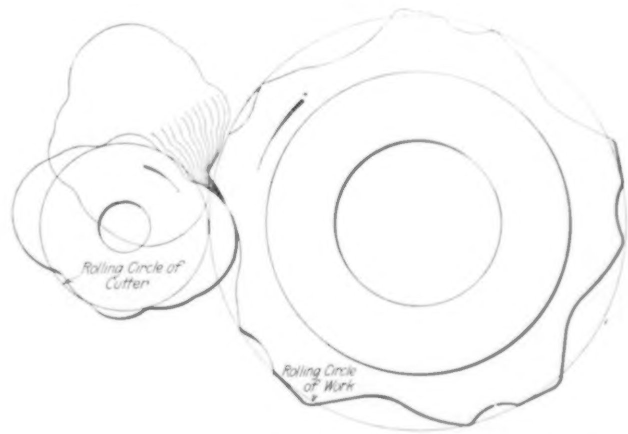


FIG. 18 DIAGRAM ILLUSTRATING HOW OUTLINE FOR CAM IN FIG. 17 IS DETERMINED

The other illustrations give the various attachments to the lathe. (*The Iron Age*, vol. 102, no. 16, October 17, 1918, pp. 945-948, 10 figs., *d*)

Measuring Instruments

COMBUSTION CONTROL METER. Description of a new system of instruments recently developed for facilitating the control of furnace combustion.

One of the features of this system is the application of a hollow tile to the bridge wall of a boiler. The principle of operation is as follows:

The hollow, self-cleaning tile is placed in the center of the bridge wall and near the top. Hot gases from the furnace are bypassed through the passage in the bridge wall to the rear of it. A hole is provided in the side wall of the furnace and extends into the hollow tile, and in it two base-metal thermocouples are inserted in such a manner that the ends of the thermocouples are out of the direct path of the flame and no ashes can accumulate in the pockets and around the couples.

One of the couples is connected to an indicating pyrometer placed on the boiler front in view of the fireman, and the other is connected to a recording pyrometer placed in the engineer's office or at some other point. On the same panel with this instrument is placed a 20-point rotary switch. The switch is so arranged that either the bridge wall or the uptake temperature may be read.

When a furnace meter indicates the temperature, it also indicates in an approximate manner the output of the boiler. With the damper wide open the maximum volume of the gas passes through the furnace. If there are holes in the fire, this volume is cooled and the pyrometer will register a lower degree of temperature. If the grate is clogged, the volume of air is reduced and the temperature is reduced, which is also registered on the chart of the recording pyrometer. Therefore, a high temperature registration on the chart not only indicates the degree of furnace efficiency, but gives a check on whether the boiler is producing a high or a low output.

The temperature graduations of the chart shown in Fig. 19 are in hundreds. The high peaks represent high furnace temperature. The chart record is composed of dots that are made at intervals of 30 seconds. When the furnace is fired at a point

below the peaks, less heat is lost and the average temperature is maintained at a high point. These dots show just what is taking place in the furnace.

The furnace meter gives a comparative temperature record of the gases in the furnace and the actual temperature of the gases in the uptake. The record of the uptake gases indicates the following: A high temperature shows one or all of three conditions; namely, dirty tubes, a hole in the baffles or excess of coal per square foot of grate surface. Low temperature indicates leaking setting, poor fuel or abnormal draft.

The record of the bridge-wall gases by comparative temperature shows the condition of the fire as indicated by the temperature line and spacing dots on the chart, the quality of coal used, method of firing the furnace and the opening and shutting of the damper. (*Power*, vol. 48, no. 17, October 22, 1918, pp. 599-600, 4 figs., *d*)

Military Engineering (See Refrigeration)

Munitions (See Machine Tools)

TABLE 3 VAPOR PRESSURE OF HYDROGEN BETWEEN ITS BOILING POINT AND CRITICAL TEMPERATURE

θ	T	ρ (in Cm.)	ρ (in Atmos.)	Δ T (Calc.-Obs.) Per Cent
Deg. K.	Deg. K.			
−248.50	24.59	219.92	2.8937	+0.05
247.48	25.61	267.99	3.5262	−0.04
246.65	26.44	319.80	4.2080	+0.02
245.87	27.22	370.65	4.8770	+0.02
245.80	27.29	376.30	4.9524	+0.03
245.68	27.41	384.32	5.0566	+0.02
244.70	28.39	475.46	6.2561	+0.25
243.22	29.87	601.52	7.9148	+0.17
241.73	31.36	748.42	9.8476	+0.05
241.07	32.02	822.6	10.825	+0.03
240.49	32.60	893.1	11.752	+0.01
240.16	32.93	936.4	12.322	0.00

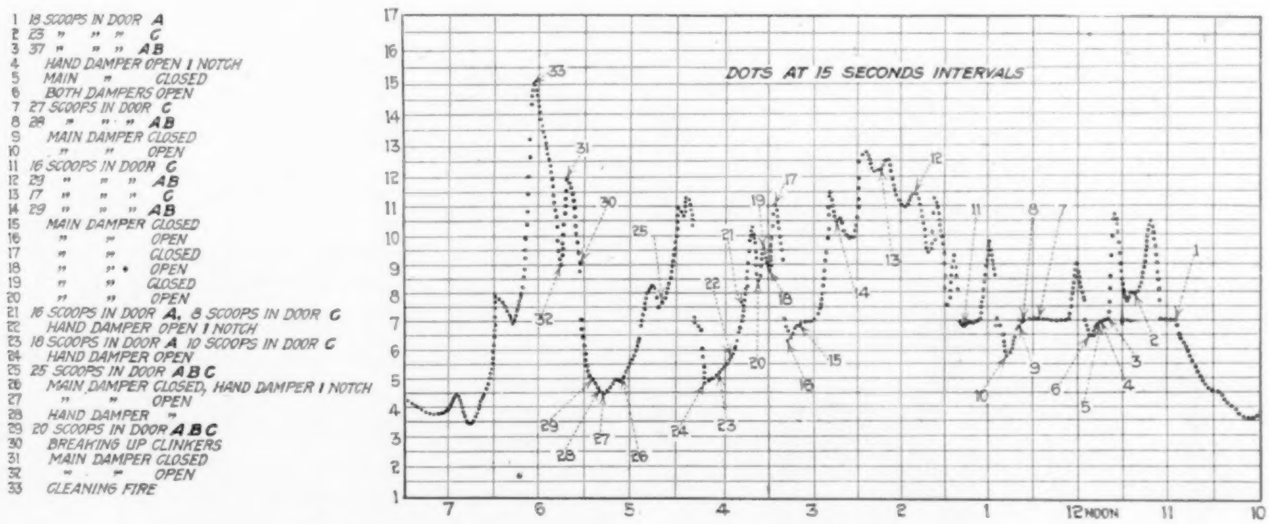


FIG. 19 CHART SHOWING THE VARIATION IN FURNACE TEMPERATURE

Physics

THE SPECIFIC HEAT AT LOW TEMPERATURES, IV, MEASUREMENTS OF THE SPECIFIC HEAT OF LIQUID HYDROGEN. PRELIMINARY RESULTS ON THE SPECIFIC HEAT OF SOLID HYDROGEN AND ON THE HEAT OF FUSION OF HYDROGEN, W. H. Keesom and H. K. Onnes. (*K. Akad. Amsterdam, Proc.* 20. 7. pp. 1000-1004, 1918. Comm. No. 153a from the Phys. Lab., Leyden)

The determinations were carried out as in the case of nitrogen. The results obtained were as shown in Table 4.

Preliminary determinations of the specific heat of solid hydrogen gave at T = 12.55 deg. K., the value 0.64. For the heat of fusion per gm. of hydrogen the mean value of 15 cal. (15 deg.) was obtained. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 379)

THE MEASUREMENT OF LOW TEMPERATURES, XXVII, VAPOR PRESSURES OF HYDROGEN IN THE NEIGHBORHOOD OF THE BOILING-POINT AND BETWEEN THE BOILING-POINT AND THE CRITICAL TEMPERATURE. P. G. Cath and H. K. Onnes. (*K. Akad. Amsterdam, Proc.* 20. 7. pp. 991-999, and 20.8. pp. 1155-1159, 1918, Comm. no. 152a from the Phys. Lab., Leyden)

Previous determinations of the vapor pressure of hydrogen have been extended. For the measurement of temperature an improved helium thermometer was employed. The results obtained are summarized in the following table. The temperatures have been reduced to the absolute scale, using the corrections deduced from the Leyden determinations of the compressibility of helium.

In Table 3 the pressures are given in international cm. of mercury at 0 deg. cent., and in international atmospheres respectively, the international atmosphere at Leyden being taken equal to 75.9488 cm. Hg. at 0 deg. cent. The vapor pressure can be satisfactorily represented by the equation (ρ being expressed in international atmospheres).

$$T \log \rho = -56.605 + 3.8015\, T + 0.10458\, T^2 + 0.003321\, T^3 - 0.00005102\, T^4$$

In the measurements at $\theta = 244.70$ and $\theta = 243.22$, the deviations are greater than might have been expected, and it is assumed that some unexplained experimental error must be present. A redetermination of the boiling point gave the value T = 20.39 deg. K. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 377, *eA*)

ULTRAMICROSCOPIC INVESTIGATION OF VERY THIN METAL FILMS OBTAINED BY EVAPORATION IN A HIGH VACUUM. W. Reinders and L. Hamburger. (*K. Akad. Amsterdam, Proc.* 20, 8. pp. 1135-1154, 1918).

This is a continuation of previous investigations, a method being here described by which the metal films can be protected by films of either calcium fluoride or Canada balsam or both while still in a vacuum. The elements investigated were W, Mo, Pt, Fe, Ni, Au, Ag, Mg, Zn, Cd, and C. The elements of high melting point, W, C, Mo, Pt, Ni, and Fe, give films which are optically either completely non-resolvable (W, C, Pt, and Fe), or for the most part non-resolvable with another part containing distinctly separate particles. The elements of lower melting point, Au, Ag, Cu, Mg, Zn, and Cd, show a far greater tendency to give a film consisting of a connected network of ultra-microns. The conclusion is drawn that in proportion as the temperature of incandescence required for slow sublimation is higher, the finer the structure of the sublimate (film) formed. Experiments in which the temperature of the glass on which the film was deposited

TABLE 4—SPECIFIC HEAT OF LIQUID HYDROGEN

Quantity of Hydrogen in Gm.	Mean Temperature	Specific Heat of Hydrogen in Cals. 15 deg. per degree K.	Atomic Heat in Cals. 15 deg. per degree K.
2.89	16.03_5	1.87	1.88
3.17	15.81	1.70	1.71
3.17	16.80	1.84	1.85_5
3.52	14.71	1.67	1.68
3.52	15.38	1.78	1.79
3.50	14.82_4	1.74	1.75
3.50	16.30	1.85	1.87
3.50	17.63	1.99	2.00
3.50	18.67	2.08	2.09
3.50	19.41	2.18	2.20
3.50	20.11	2.24	2.26
3.51	15.24_8	1.84	1.82
3.51	16.37	1.90	1.89
3.51	17.37_8	1.99	1.98
3.51	19.07	2.17	2.16

was varied, showed that the greater the vapor pressure of the metal at the temperature of the glass on which it is deposited, the coarser is the structure of the deposit. Various grades of coarseness can be observed, varying from deposits which are optically non-resolvable to deposits on which the smaller particles are distinctly separate.

W, Mo, C, Fe, Ni, and Pt give colorless films, whereas the other elements give colored films which, in the case of Ag, Au, and Cu, may show a great wealth of color. The color does not depend directly on the structure of the metal. For example, Au, Ag, and Cu show the same sequence of colors in mosaic deposits at room temperatures as in the structureless deposits formed at the temperature of liquid air. No coloring sets in with Pt, W and Fe when the structureless deposit is transformed into a mosaic deposit by local heating. The conclusion is drawn that the capacity for displaying color is an individual property of the metal and is determined by the selective absorption of the atoms. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 350, *e*)

Power Plants

A NEW 25,000-KW. POWER PLANT FOR DAYTON, OHIO. Description of a station laid out to house 100,000 kw., but now having a capacity of 25,000 kw. in two units.

The turbines are of the nine-stage horizontal impulse type making 1800 r.p.m. At 200 lb. gage pressure, 125 deg. superheat and a vacuum of 29 in., these units are guaranteed to produce a kilowatt hour at half load on 12.4 lb. of steam; at three-quarter load, 11.95, and at full load, 12.4 lb.; (only the first value is apparently guaranteed).

The condensers are of the two-pass surface type, each containing 15,000 sq. ft. of tube surface, or 1.2 sq. ft. of surface per kilowatt of generator rating. The circulating pumps are mounted on the intake pipe, and are driven by a motor at one end of the shaft and a turbine with reduction gearing at the other end. Each drive may be used as dictated by exhaust-steam requirements to maintain the hot balance of the station.

An interesting feature in connection with the condenser installation is the arrangement for supplying circulating water. In this case, instead of the usual long, upstream intake, an intake basin has been constructed by the dragline method measuring 60 x 330 ft. and about 12 ft. deep. The mouth of the basic points downstream, so that the current of the river does not flow into it. This obviates much of the trouble usually encountered from gravel, driftwood and sewage, and also provides short intake tunnels.

The turbines are served by three boilers arranged in line along a firing aisle parallel to the turbine room, instead of at right angles to it, which gives a more symmetrical design. The boilers are of the cross-drum type, each having 13,730 sq. ft. of steam-making surface, so that one boiler horsepower supplies 6 kw. of generating capacity, a ratio exceedingly high, unless future provision is to be made for reserve capacity.

Special attention has been paid to the coal-handling apparatus, which consists of a steam hoist operating a clamshell bucket discharging into a hopper above the bunkers. From the hopper the coal passes through a motor-driven crusher into a cable car, where it is weighed before being passed to the steel bunker over the boilers. The system is rated at 90 tons per hour and is large enough to serve half of the ultimate plant. The ashes from the hoppers under the stokers are delivered by gravity into side-dump cars, which are hauled out to the low ground around the station by a gasoline-engine-driven tractor.

The water supply for the station is taken from wells, and, as it is unfit for boiler use without treatment, a hot-process water softener was installed to take care of the makeup, which was estimated to amount to about 2 per cent of the total water evaporated.

To keep down the size of the water-softening equipment a 10,000-gallon tank was placed on the roof of the building. It is supplied with condensate from a concrete tank in the basement by means of two 100-gallon-per-minute pumps, the operation of which is controlled by a float valve in the roof tank.

The water from the softener, which is heated to 200 deg. fahr., goes directly to the heater whenever the water level in the concrete overflow tank for the heater is lowered. The softener is of the Vater type, and is capable of treating 3000 gallons of water per hour as it comes from the wells (about 26 grains of hardness per gal). (*Power*, vol. 48, no. 18, October 29, 1918, pp. 620-624, 3 figs., *d*).

Railroad Engineering

THE LOCOMOTIVE FEEDWATER HEATER. "The more extended use of the feedwater heater in locomotive service is awaited with confidence as to its ability to effect a saving of from 15 to 20 per cent in fuel, in accordance with results which have already been obtained in laboratory tests."

The editorial which starts with the above quotation makes a further claim that feedwater heating is especially adaptable to locomotive service.

On a locomotive the closed feedwater heater acts as a condenser used, however, rather for the purpose of condensing raw water to be used as boiler feed. The exhaust steam admitted to the heater is at such a low pressure that the greater portion of the heat contained therein is latent heat, which on being abstracted leaves the steam in the form of water at or near the boiling temperature. Were it not for the oil content in this water it would be of advantage to return it to the boiler, as then it would in itself constitute an increase of nearly one per cent in the overall efficiency of the machine. In time, with the improvement in the lubricating methods, it may, indeed, become possible to avail ourselves of this possibility.

In stationary feedwater heaters the condensation of steam on the surface of the tubes prevents the contact of additional steam with these tubes and serves to insulate them to an appreciable extent. In locomotive service the tubes are more rapidly freed of this condensation, because of the jarring of the engine as it passes over the track. This feature of rapidly freeing the tubes of condensation is of such importance that in stationary installations vertical instead of horizontal heaters are frequently used, and experiments are being made with heaters having lead-, zinc- and amalgam-covered tubes to which the water adheres less tenaciously than to steel or brass.

A feedwater heater also has an effect on increasing the output of a locomotive through reduction in back pressure. The abstraction of 14 per cent of the steam from the exhaust passage before the steam undergoes the choking effect at the nozzle, is equivalent to an increase in the size of the nozzle, since a lesser amount of steam (86 per cent instead of 100) is required to find its way through the passage. This phenomenon is unmistakably evident from indicator cards and dynamometer diagrams secured in locomotive tests. (Editorial in *Railway Review*, vol. 63, no. 15, October 12, 1918, p. 541, *gp*)

Refrigeration

REFRIGERATING PLANT AT THE INTERMEDIATE DEPOT FOR THE AMERICAN ARMY IN FRANCE, Robt. K. Tomlin, Jr. Description of the refrigerating plant at the Intermediate Depot for the American Army in France, designed to care for storage of 5000 tons of meat.

The plant is of a very large size, consisting of a group of twelve principal buildings, several miscellaneous buildings and a concrete reservoir 55 x 60 ft. in plan. The engine-, boiler- and pump-room equipment comprises eight 250-hp. horizontal tubular boilers, four refrigerating machines having a total capacity of 1100 tons of refrigeration, two 150 kva. electric generators and three turbine-driven centrifugal pumps, each with a capacity of 180 gallons per minute.

Refrigeration is by direct expansion of the ammonia circulating in coils hung from the ceiling of the building, which is divided into five rooms, each with a capacity of about 1000 tons of meat.

The designs for the plant were prepared at Washington, but simultaneously on the spot a so-called Ice Plant Company was organized of engineers, about 350 men strong, most of whom were recruited from the personnel of the large packing companies of the Middle West. The work was started in France in December, 1917, and, notwithstanding all the difficulties that surrounded construction work in France in those days, the plant was placed in operation on May 2, 1918, which is certainly an excellent record for a plant of that size.

There are certain features of construction which appear to be of special interest. Thus unusual pains have been taken to insure flexibility in the layout of the piping. A break in the piping would be especially serious, as in France ammonia losses would not be easy to replace. The ammonia lines are sectionalized by the installation of valves at frequent intervals, so that in case of a break a section of piping may be cut out of the system and ammonia losses thereby reduced.

Further, zero temperature is maintained in the freezing room. This fact, in connection with allowing meat to remain there for four days before shipment, makes it possible to dispense with special refrigerating cars and to forward the frozen meat in plain box cars. This feature of plant operation is of exceedingly great importance in view of the present car shortage in France and the undesirability of introducing special purpose rolling stock. (*Power*, vol. 48, no. 17, October 22, 1918, pp. 596-598, 4 figs., *d*)

Testing and Measurements

ELECTRIC DYNAMOMETERS FOR AIRCRAFT ENGINE TESTING. Description of very large dynamometers developed for testing the Liberty engine and other big aircraft power plants. Such dynamometers became necessary after it was found that the so-called club test (by means of a calibrated propeller) did not prove reliable. Two Sprague dynamometers are described in the present article. One size has a nominal rating of 300 hp. at 1325 r.p.m. and a maximum rating of 450 hp. at 1700 r.p.m. A smaller machine has also been developed with a nominal rating of 200 hp. at 1300 r.p.m. and a maximum rating of 300 hp. at 1650 r.p.m.

Combinations are frequently made of two of the smaller machines for testing up to 500 hp. and of two of the larger machines for testing up to 800 hp. For such combinations the electric control and torque-measuring system have been worked out so that the torque is read on a single scale and the load is controlled by a single handle just as in a single-unit machine.

In conducting dynamometer tests it is important that the loads at different speeds follow approximately the speed-horsepower curve of the propeller that would be used with the engine. This follows the cube law. It is claimed that results obtained on torque stands with clubs frequently vary as much as 10 or 20 per cent from the true horsepower output. With electric dynamometers much greater accuracy is secured.

A recent application of the electric dynamometer is for the making of efficiency and endurance tests on propellers. The dynamometer is used as a driving motor and the propeller is mounted upon a sliding shaft coupled to the dynamometer in such a manner that not only the torque required to drive the propeller is measured but the thrust or reaction is indicated. This arrangement is proving of great value in making overspeed tests on propellers. (*Automotive Industries*, vol. 39, no. 16, Oct. 17, 1918, pp. 675-677 and 696, 5 figs., *dp*)

0 DEG. OR 20 DEG., OR 0 DEG. AND 20 DEG. (PURE NORMAL TEMPERATURE OR NORMAL TEMPERATURE AND STANDARD TEMPERATURE), F. Plato. (*Zeitsschrift Instrumentenk., Beib.* nos. 9, 10, pp. 49-54, May 5, 11, and 12, pp. 61-66, June 15, 1918) So long as instruments exist whose readings are dependent on temperature, there will be a need for fixing a particular temperature for reference. When the choice of this temperature is restricted to a select circle, then we speak of a standard temperature, but when state recognition is given, or international sanction is obtained, then the standard becomes a normal temperature. A large number of normal temperatures are in existence, but of these only two (of French origin) are not arbitrary, namely: the temperature of melting ice, and 15 deg. cent. (proposed by Gay-Lussac as the average temperature of the earth). The present paper contains a discussion of the various temperatures in the neighborhood of 15 deg. cent. which have been proposed from time to time. For many purposes 20 deg. has been found very convenient, and the advantages together with the drawbacks are dealt with at some length. The discussion includes that of other units in different systems. Section 1 considers the temperature of melting ice as a natural phenomenon. Section 2 treats the latter from the standpoint of requiring no thermal measure for its determination. In section 3 its independence with respect to temperature scales is examined. Here the various thermometric scales come under review. In section 4 the temperature of melting ice as a starting-point is shown as a safeguard against sign errors. In section 5 the possibility of international agreement to this temperature as normal temperature is discussed. The different national temperatures are here described. Following this comes an exhaustive discussion on the question of adopting 20 deg. cent. as a special standard temperature which would be especially beneficial to industry. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, pp. 377-378, *g*)

THE RELATIONSHIP OF IMPACT VALUE TO MAXIMUM STRESS, ELONGATION AND BRINELL HARDNESS, G. Berndt. (*Zeits. Vereines Deutsch. Ingenieure*, no. 62, pp. 421-422, July 6, 1918) The impact value was measured of some 40 samples of basic Siemens steels of which the elastic limit, maximum stress, percentage elongation, and Brinell hardness were all known. With the exception of the elongation these values at first increased as the impact value rose, reaching a maximum with an impact value of 1.3 kg-m., after which they decreased rapidly and became finally more or less stationary. The impact value, which is of all the properties measured the most sensitive in detecting brittleness, appears to increase with the ferrite content of the steel. Two photomicrographs are included. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p 347, *t*)

Thermodynamics

THE JOULE-THOMSON EFFECT AND THE EQUATION OF STATE FOR GASES AT SMALL PRESSURES, M. Jakob. (*Ann. d. Physik*, 55. 7. pp. 527-544, June 21, 1918. From the *Physikal-Techn. Reichanstalt*). From Planck's partial differential equation

$$\frac{10^4\,T^2}{427}\left(\frac{\partial v\,T}{\partial T}\right)_p = (c_p)_o\left(\frac{\partial \triangle}{\partial p}\right)T,$$

the equation of state of a gas may be derived if, besides its specific heat $(c_p)_o$ for $p = 0$, the integral Joule-Thomson effect $\triangle$ for an infinitesimal pressure is given as a function of the initial pressure p (kg./cm.^{2}) and the temperature T, also an isothermal of the state is given for the determination of the arbitrary integration function when the integration is made with respect to T. From the throttle experiments of Bradley and Hale, and of Noell for air, the empirical equation $(\partial\triangle/\partial p)\,T = Ap^3 + Bp^2 + Cp + D$ was obtained, wherein A, B, C, D are simple rational func-

tions of T. From these equations and an isothermal by Amagat and Holborn and Schulze follows the equation of state: $v = \mathrm{R\,T}/10^4 p + \mathrm{A}' p^3 + \mathrm{B}' p^2 + \mathrm{C}' p + \mathrm{D}' + \mathrm{E}'\,\mathrm{T}$, where R is the gas-constant, and A′, B′, C′, D′ are similar functions of T as A, B, C, D. E′ is a determined rational integral function of p. The author has found this equation of state valid at high pressures, *e.g.* at — 140 deg. cent. up to 30 atmos., at — 80 deg. cent. to 200, at 0 deg. to 700, at 200 deg. to 1000 atmos. The relations at very low pressures have been considered, and for $p = {}^\circ$ the following equation evolved: $\partial (pv) / \partial p = \mathrm{D}' = -\ 191310/\mathrm{T}^4 + 10229/\mathrm{T}^3 + 147.63/\mathrm{T}^2 + 0.08973/\mathrm{T} + 0.00065708$. This equation is established in the present paper and compared with known experimental data. This comparison gives a sharp criterion as to the validity of the above equation of state for very small pressures, and between what temperature limits. It is shown that the last equation holds good for other gases after the introduction of the necessary data. Section 2 of the paper deals with the inadmissibility of the identification of an ideal and of a real but infinitely diluted gas. Section 3 develops the equations of state and the Joule-Thomson effect according to van der Waals and Berthelot are considered. The Joule-Thomson effect of infinitely dilute air according to theory and experiment, forms the subject of section 5. Section 6 deals with the derivation of a real but infinitely dilute gas from Mariotte's law. In section 7 the Joule-Thomson effect of other gases is calculated from that of air, according to the method of corresponding states. The equation of state is found to hold for very low pressures as for very high, and so to be of general applicability. (*Science Abstracts,* Section A—Physics, vol. 21, pt. 9 (no. 249), Sept. 30, 1918, p. 381)

NEW HEAT-TRANSMISSION TABLES, Wm. R. Jones, Mem.Am.Soc.M.E. A compilation of factors of heat transmission through various classes of building materials, with index of authorities quoted.

The materials considered cover glass, single, double and various types of skylights; various types of walls, such as brick, brick and plaster, concrete, as well as tiles, etc.

The tables represent apparently a very large amount of work and are of considerable interest. (*Heating and Ventilating Magazine,* vol. 15, no. 10, October 1918, pp. 36 to 41, *gpA*)

Varia

GOVERNMENT COMMISSION COMPOSED ENTIRELY OF ENGINEERS. During the past summer, the New Brunswick government appointed a commission to investigate the water-power situation in that province. The appointment of such a commission is, of course, not unusual, and would not warrant special notice except for the fact that this commission, contrary to the usual custom in appointing various government commissions, consists entirely of engineers. C. O. Foss, chairman of the commission, has been connected with the Canadian Society of Civil Engineers and The Engineering Institute for a great many years. He is chief engineer of the St. John and Quebec Railway. B. M. Hill, a member of the commission, is provincial engineer. Mr. Hill is an engineer who has taken considerable interest in public affairs, and at one time contested a seat in the local legislature. W. E. McMullen, secretary of the commission, is the engineer of the Crown Lands Department.

This commission is acting in coöperation with the Dominion Water Power Branch, so that the technical aspects of the water-power situation in both the provinces of Nova Scotia and New Brunswick are being handled by a single engineering organization, which results in maximum efficiency and economy. Although the New Brunswick Water Power Commission was not in a position to begin active operations until early in August last, already eleven stream-measurement stations have been established in various parts of the province and an adequate foundation laid for obtaining basic stream-flow data in various parts of the province. (*Journal of The Engineering Institute of Canada,* vol. 1, no. 7, November 1918, p. 336, *g*)

EFFECT OF AIR TOOLS ON WORKMEN. At the congress of the National Safety Council in St. Louis, September 18-19, a paper under the above title was presented by Francis M. Barnes, Jr., covering reports of several investigations carried out recently.

The following conclusions are drawn by the writer, and he himself acknowledges that they are subject to some limitations because they are drawn from a comparatively small series of observations:

1 Structural-steel workers, shipbuilders and stone cutters, as a class, enjoy good general health, and are not, because of their trade, especially susceptible to any particular disease.

2 Stone cutters are liable to a disorder affecting the hands, especially the left hand.

3 This disorder of the hands is of a vascular character, not due to organic changes in the circulatory system, but dependent upon vasomotor reactions.

4 These reactions are physiological in character and are occasioned by three factors incident to the work of stone cutting: mechanical irritation of the skin, continued muscular contraction of a cramping nature, and low temperature.

5 Of these three factors, cold is considered the most important because the condition only occurs during the severely cold weather and never in the summer, and warmth and measures to restore the circulation (rubbing, swinging the arms, and the like) cause its disappearance.

6 It cannot be caused by the effect of the air hammer alone, because it occurs in those who have not used the air hammer. It does not occur in warm weather when industry is at its height, and, therefore, when the air hammer is most in use. It occurs mostly in the left hand, and not in the right in which the hammer is held.

7 The vasomotor disorder is of temporary duration, and is not known to have resulted in permanent disability of the hand, nor itself to have been the cause of development of any other local or constitutional disease.

8 It is possible that once having occurred, the person is rendered more susceptible to its reappearance, just as is the one who has had his ears or fingers frostbitten by the cold.

9 There is no sufficient reason in the signs and symptoms presented in this disorder to conclude that one has to do with Raynaud's disease, acroparesthesia, neuritis or an occupational neurosis.

10 The institution of measures to warm the chisel before and while using, enlarging the shank of the chisel and covering it to make it possible to hold without so cramping a grip, the wearing of gloves, and the discontinuance of the prevalent custom of blocking the exhaust outlet, and thus forcing a draft of chilled air out along the chisel and onto the fingers of the left hand, would do much toward the prevention of this trouble. (*The Iron Trade Review,* vol. 73, no. 19, November 7, 1918, pp. 1071-1072, *g*)

NEW YORK-CHICAGO AIR-MAIL ROUTE. Postmaster-General Burleson announces that the New York-Chicago air-mail route will be inaugurated between December 1 and December 15. The exact time of the establishment of the service will depend upon the time of the receipt of the Post Office Department of the necessary airplanes to operate the line.

The route will be laid out in three legs; the first from New York to Bellefonte, Pa., a distance of 215 miles, with an emergency station and machine midway to Lehighton; the second leg from Bellefonte to Cleveland, a distance of 215 miles, with an emergency station at Clarion, Pa., a distance of 87 miles from Bellefonte; the third leg from Cleveland to Chicago, a distance of 323 miles, with an intermediary mailing station at Bryan, O. (*Official Bulletin,* October 25, 1918, p. 1)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE world war has changed for most every one his point of view of life, and it should particularly change the motives of the engineer. He has rendered indispensable service in the world war, and is properly receiving the credit therefor. The opportunity offered him by reconstruction is many fold greater than that he has had in the military operations.

Mr. Charles M. Schwab, at his reception in the Metropolitan Opera House, Philadelphia, to the members of the staff of the Home Office of the Emergency Fleet Corporation, said that "the measure of a man's worth is the service he renders." This was the rejoinder to a remark by the Secretary of the Navy, that Mr. Schwab was so rich that he didn't want any more money, whereas the Secretary of the Navy was so poor that he wouldn't know what to do if he had money.

Mr. André Tardieu, the Minister of Franco-American War Affairs in the French Cabinet, has just arrived again in this country, and frankly invites this nation to "assist France to her feet."

The Society is in receipt of an invitation from President Millerand, of the Congrés Général du Genié Civil, which is to take place in Paris the middle of December, to send a delegate and assist in conferences with respect to reconstruction problems. These problems obviously will be mainly of civil engineering, and it is probable that the representatives of that branch of engineering will form the largest part of the delegation, but there are numerous phases of particular interest to mechanical engineering on which our delegate can help, and the Secretary takes this means of soliciting suggestions and volunteers of service not only for this but any others on which the Society may call when occasion arises.

I have already mentioned in my previous letter the visit of the delegation from the Government of Belgium which has just returned. I have also had a call this month from the Governmental representative of Holland, who was seeking advice with respect to the development of water powers, and general information on opportunities in industrial development for Holland's colonies.

The spirit of the Society must be that of the individual. How can we render the greatest service to the world? At the Annual Meeting we are to have several addresses which will assist our members by way of suggestion.

Along these lines it is with particular satisfaction that I can announce the formation of the American Engineering Standards Committee, which in organization and scope of work is parallel to the wonderful British Engineering Standards Association. With the development of our relations with all countries, the need for standardization becomes still greater, particularly with our desire for foreign trade. Standardization is absolutely essential to trade, particularly of the type in which we in the United States are especially successful, namely, the production of articles in great quantities.

With the opening of the new hopes for all peoples for greater opportunity of self-development comes the same opportunity to the engineering profession in its peculiar and specialized work.

The Secretary solicits correspondence with members who are desirous of participating in this greater movement.

CALVIN W. RICE,
Secretary.

Council Notes

A MEETING of the Council was held on the afternoon of Friday, November 8, 1918, in the rooms of the Society. There were present: Charles T. Main, *President,* H. de B. Parsons, R. H. Fernald, Arthur M. Greene, Jr., Spencer Miller, C. H. Benjamin, D. Robert Yarnall, Wm. H. Wiley, *Treasurer,* Ira N. Hollis, Charles T. Plunkett, D. S. Jacobus, George M. Forrest, *Chairman Finance Committee,* Jesse M. Smith, *Chairman Committee on Constitution and By-Laws,* George A. Orrok, *Chairman Publication and Papers Committee,* Calvin W. Rice, *Secretary,* and by invitation, George J. Foran, *Chairman Engineering Resources Committee.*

BUSINESS FROM THE PRESIDENT

Rehabilitation of Wounded and Readjustment of Industries to Peace. The President was authorized to appoint a committee to take up the question of the way in which this Society can best assist in the reconstruction problems after the war, the readjustment of the industries, and coöperation in war relief work, including the American Red Cross.

Invitation to Paris Conference. The President reported an invitation from the Société des Ingénieurs Civils de France, to this Society to send a delegate to an Engineering Congress to be held in Paris, in December. As announced elsewhere, by subsequent action of the Executive Committee, President Main was appointed to represent the Society at this conference.

STANDING COMMITTEES ON ADMINISTRATION

The annual reports of these committees were received and ordered printed. They appear elsewhere in this issue of THE JOURNAL.

Membership Committee. Under By-Law 16 the remission of dues of the following members who have either paid for 35 years or reached the age of 70 and paid for 30 years was recorded:

Albrecht, Otto.	Emery, A. H.	Sellers, C., Jr.
Alden, Geo. I.	Forsyth, R.	Smith, A. W.
Allen, F. B.	Forsyth, W.	Smith, G. H.
Angstrom, Carl.	Halsey, F. A.	Smith, Oberlin.
Baldwin, Wm. J.	Henry, Wm. T.	Stangland, B. F.
Ball, F. H.	Herrick, J. A.	Stearns, T. B.
Bancroft, J. S.	Higgins, Geo. F.	Stratton, E. P.
Barnes, W. F.	Hill, Wm.	Suter, Geo. A.
Barrus, Geo. H.	Hollerith, H.	Swain, G. F.
Betts, A.	Howard, C. P.	Tallman, F. G.
Bilgram, Hugo	Hugo, T. W.	Taylor, Stevenson.
Bond, Geo. M.	Hunt, R. W.	Thomas, E. W.
Brooks, E. C.	Landreth, O. H.	Thorne, Wm. H.
Burdsall, E.	Lanza, Gaetano.	Townsend, David.
Byllesby, H. M.	McEwan, J. H.	Trump, E. N.
Capen, Thos. W.	McFarland, W. M.	Walworth, A. C.
Carpenter, R. C.	Martens, F.	Warner, W. R.
Cheney, W. L.	Marx, Henry.	Webber, H.
Clarke, Chas. L.	May, DeCourcy.	Webster, H.
Cloud, John W.	Miller, L. B.	Weston, E.
Cogswell, Wm. B.	Mullen, John.	White, J. J.
Coon, J. S.	Newcomb, Chas. L.	Whitham, J. M.
Cox, J. D.	Porter, H. F. J.	Wiley, W. H.
Dean, F. W.	Raynal, A. H.	Wood, W.
Durand, W. F.	Scheffler, F. A.	Worthington, C. C.

Finance Committee. The Secretary reported the death of Mr. R. M. Dixon, *Chairman,* and the following resolutions were ordered entered on the minutes:

RESOLVED: That in the death of Robert M. Dixon, for ten years a member of the Finance Committee and for more than eight years its Chairman, the Society has lost one of its most valued members, and a leader whose wise counsels and mature judgment contributed in a most conspicuous manner to the present sound financial condition of our Society, which is in itself a most flattering tribute to the financial and executive ability of the engineer, the citizen, and lovable companion, whose loss we mourn. And be it further

RESOLVED: That a copy of these resolutions be spread upon the minutes of this meeting and a copy properly amplified with historical data be engrossed for presentation to the family of Mr. Dixon, and for publication in THE JOURNAL and TRANSACTIONS of the SOCIETY.

On recommendation of the Publication Committee, approved by the Finance Committee, the purchase of "The Engineering Index" from Industrial Management, was authorized.

The President announced that the Committee had selected Mr. George M. Forrest to act as Chairman and he had appointed Mr. Frank E. Law to fill the unexpired term of Robert M. Dixon.

Meetings Committee. On the recommendation of this committee, the status of the sub-committee on Protection of Industrial Workers was changed to that of a special committee.

STANDING COMMITTEES

The annual reports of the Standing Committees on *Library, House, Research, Standardization and Public Relations* were received.

Standardization Committee. The Secretary reported the appointment of Clifford B. LePage, Assistant Professor of Physics at Stevens Institute of Technology, as Acting Secretary of the American Engineering Standards Committee, in addition to the work which Mr. LePage was doing in the Society as secretary of all the technical committees.

PROFESSIONAL COMMITTEES

Patents Committee. The report of Mr. E. J. Prindle, representative of the Society on the Patents Committee of the Engineering Council, was received.

Refrigeration. The progress report of Dr. D. S. Jacobus, Chairman of the Refrigeration Committee, was received.

Power Test Committee. The resignation of Mr. George H. Barrus was accepted. Mr. Barrus was thanked for his services to the Society.

Sub-Committee of Fuels. On the recommendation of Prof. Charles Russ Richards, this committee, which was appointed to act in an advisory capacity to the Bureau of Mines, was discharged with thanks.

Boiler Code. This committee as now constituted was continued for one year.

The Council received a delegation from the National Boiler and Radiator Manufacturers' Association in the matter of Par. 363 and 374 of the Code relating to heating boilers.

The Boiler Code Committee was requested to keep before them these two articles, and should the state of the art prove that either of them is inadvisable, action is to be taken by the committee to rectify them. This action was ordered communicated to the representatives of the Association.

Interpretations Nos. 200 to 206 were approved.

Increase of Membership. The report of this committee was received. This report carried with it the appointment on this committee of Mr. G. M. Forrest, Chairman of the Finance Committee.

SPECIAL COMMITTEES

Emergency War Training. This committee was discharged with thanks.

Engineering Education. The report of the Committee on Engineering Education, as given in A Study of Engineering Education, by Dr. Charles R. Mann, printed under the auspices of the Carnegie Foundation for the Advancement of Teaching, was received and the committee of this Society discharged with thanks.

APPOINTMENTS

By the President. W. W. Macon, H. L. Aldrich, A. J. Baldwin on a delegation of technical editors to England as the guests of the British Ministry of Information.

F. R. Low, Chairman, George H. Barrus and H. L. Gantt, to prepare a memorial to the late Mr. William Kent.

By the Council. Walter M. McFarland to fill the unexpired term of two years of R. M. Dixon, as Trustee of United Engineering Society.

The Council approved the principle of the appointment on the Engineering Council of the President of the Society during his term of office.

M. E. Cooley, nominee for President, was appointed for one year.

George J. Foran, reappointment on the Engineering Council for three years.

Adjournment. To meet in New York City, on Tuesday, December 3, 1918, at 2 p.m., in connection with the Annual Meeting.

CALVIN W. RICE,
Secretary.

President Main to Go to France

The American Society of Civil Engineers some time ago received an invitation coming through the Société des Ingénieurs Civils, and the Committee of the French Engineers' Congress, with the official approval of the French Minister of Armament, Public Works and Commerce, requesting it to arrange for a delegation of American engineers to study with French engineers certain problems involved in the rehabilitation of France after the war.

This delegation was invited to come to Paris to examine in joint conference questions of utilization of commercial ports, development of navigable waterways, development of water power, and improvement of road systems. These were the only specific subjects mentioned, but it is known that the Congress will take up many other questions of development in which the mechanical, electrical and mining engineer is directly interested.

Upon receipt of this invitation a cable was forwarded by the A.S.C.E. accepting the invitation, and stating that they would organize such a delegation in coöperation with the other American National Societies.

The American Society of Mechanical Engineers, through its Executive Committee, designated President Main to become a member of this official delegation.

Index to the 1918 Journal

An index to Vol. 40 of THE JOURNAL is now being prepared, but, owing to the shortage of paper, it is not being included with this issue, as has been the custom in former years. A copy of this index will be sent to any member or subscriber whose request is received prior to January 15, 1919.

There is a possibility that the delegation will not have to sail until the latter part of the week of the Annual Meeting, in which case President Main will be in attendance at least during the opening sessions.

Bulletin on Fuel Saving in House Heating Boilers

The need for saving coal in the domestic sizes is still very urgent, particularly in view of the drop in coal production during the period of influenza, and makes of timely interest a bulletin issued by the Bureau of Mines on Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces. This is known as Technical Paper No. 139, intended to supplement Technical Paper No. 137, which covers higher rates of combustion, such as burning coal under power-plant and locomotive boilers. Both of these papers are based on the results of actual tests. Those for Paper No. 139 were divided into three groups, according to the method of charging the fuel and of feeding the air under the grate. The tests of the first group were made in a way to be comparable to those of the high rates of combustion. The tests of the second group were made under similar conditions as regards feeding of air, but the fuel was charged in large quantities at long intervals to simulate the feeding of coal in house-heating apparatus. In the third group of tests all access of air through the grate was shut off, the object being to parallel conditions when running with the fire banked and the furnace closed during the night. The pamphlet discusses the results very fully under the conditions of tests outlined.

COMPLIMENTARY DINNER TO AMBROSE SWASEY

THERE was recorded in the last number of THE JOURNAL the gift by Ambrose Swasey, Past-President and Honorary Member of the Society, of an additional $100,000 to the Engineering Foundation. As known to our members, this foundation was established by the United Engineering Society, representing the four founder societies, as the result of an initial gift by Mr. Swasey of $200,000.

In recognition of these splendid gifts to the cause of research, the United Engineering Society on November 14 gave Mr. Swasey a complimentary dinner at the Engineers' Club of New York. There were about 70 guests present, among whom were 22 past-presidents of the Founder Societies, members of the boards of government of the Engineering Foundation and the Founder Societies, members of the Library Board and officers of the Engineers' Club, making one of the most distinguished gatherings of engineers which has ever been brought together.

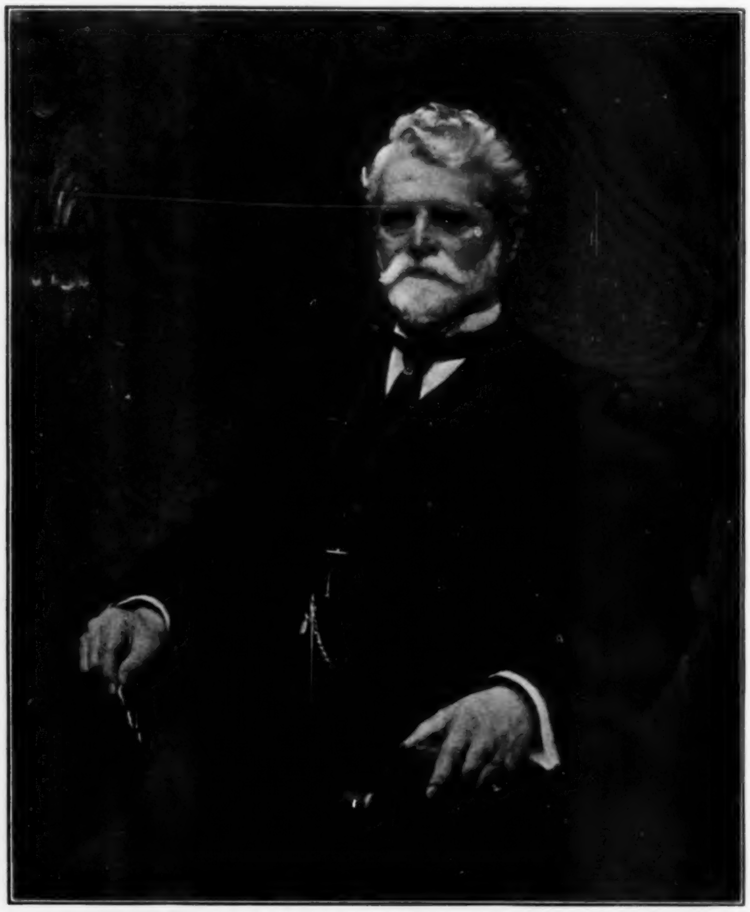
The addresses were by Mr. Swasey's life-long friends, Dr. Robert S. Woodward, President of the Carnegie Institutions of Washington, Dr. Robert W. Hunt, Past-President of this Society, and by the Chairman of the Engineering Foundation, Dr. Michael I. Pupin, with a response by Mr. Swasey. Dr. Woodward spoke in an especially happy vein, stating that he was a silent partner with Mr. Swasey, assisting by advice in the development of the gift.

The desire of Mr. Swasey to contribute so liberally to the cause of research is but a reflection of the spirit and motives which have always entered into his life work in the field of science and engineering. In the manufacture of machine tools of the finest type, the construction of instruments of precision and in the production of astronomical and optical instruments, comprising the mountings for the largest and best known of the world's telescopes, the manufacture of meridian circles, transits, range finders, etc., the results of research and investigation have been constantly required.

His interest in scientific attainments and in instruments of refinement and precision was further shown in a presidential address before the Society upon the subject of Some Refinements of Mechanical Science. In this he reviewed the development of dividing engines, of both the linear and circular types, including the remarkably accurate instrument developed at his own plant for astronomical work, besides other apparatus of a like character.

Appreciation of the need for research is greater now than at any time in the history of industry and the engineering profession and those connected with the industries generally are to be congratulated on having a foundation so thoroughly established for the promotion of scientific investigation in engineering and technology.

Besides his gifts to the Engineering Foundation, Mr. Swasey has given a great deal of pleasure and satisfaction to his friends by presenting to the United Engineering Society earlier in the year a remarkably fine portrait of himself painted by the famous French artist, Jean-Joseph Weerts. A reproduction of this painting is given herewith, taken from a photograph of the original which hangs in the Library of the United Engineering Society. Mr. Swasey sat for this portrait in Paris in 1906.



PORTRAIT OF AMBROSE SWASEY REPRODUCED FROM PAINTING BY WEERTS OF PARIS; PRESENTED BY MR. SWASEY TO THE UNITED ENGINEERING SOCIETY

The artist Weerts received his training in the studio of Cabanel and has exhibited every year in the Salon. While several beautiful paintings of a general character stand to his credit, he has excelled in portraiture through his rare talent in securing perfect resemblance, an abundant of detail and excellent finish.

Meetings of the Screw-Thread Commission

In the November issue of THE JOURNAL on page 972 reference was made to the organization of the National Screw Thread Commission and an abstract was given of the meeting of October 7. On October 21 a second hearing was held in New York and the topics for discussion at this meeting are listed below:

Pipe Threads: (1) As a national standard, is there any objection to the adoption of the American Briggs pipe-thread sizes for both taper and straight pipe threads as accepted by The American Society of Mechanical Engineers? (2) In view of the experiments on the form of pipe threads conducted by the Pennsylvania Railroad in connection with the American Society of Testing Materials which tend to show the desirability of the U. S. Standard form with flat top and bottom $\frac{1}{8}$ of the pitch; do you consider it advisable to adopt the U. S. Standard form instead of the present form which specifies a thread depth of 0.8 of the pitch with a resulting flat at the top and bottom of the thread which is quite small? (3) In your shop practice to what extent do you employ gages for checking pipe threads and what do you consider a satisfactory tolerance for ordinary commercial work stated in turns either way from the gaging notch?

Brass Tubing: (1) What is your shop practice in connection with threads cut on various forms of brass tubing? (2) To what extent do you consider it possible to standardize the general practice on the threads used on brass tubing?

Hose Couplings: (1) As a national standard, is there any objection to the adoption of the hose-coupling sizes now known as the National Standard hose couplings in the sizes from $2\frac{1}{2}$ in. to $4\frac{1}{2}$ in. as recommended by the National Fire Protection As-

sociation; Bureau of Standards; American Society of Mechanical Engineers, and other organizations? (2) What is your shop practice in the manufacture of hose-coupling threads on sizes below $2\frac{1}{2}$ in? (3) To what extent do you consider it possible to standardize commercial practice in the manufacture of hose-coupling threads on the sizes below $2\frac{1}{2}$ in?

Acme and Other Special Threads: (1) What is your shop practice in the manufacture of Acme threads and other special threads used in machine construction? (2) To what extent do you consider it possible to standardize the form of thread and pitches used in the manufacture of Acme threads and to standardize other special threads used in machine construction? (3) To what extent do you consider it possible to standardize the general practice with reference to the diameters used for Acme thread pitches?

Instrument Threads: (1) In your shop practice in the manufacture of instruments, to what extent do you use the A.S.M.E. threads; the British Association threads; metric threads; or your own special threads; and to what extent do you consider it possible to standardize commercial practice for this class of work?

Hearings were also conducted in Washington on November 8, in Detroit on November 11 and in Dayton on November 13, of which further mention will be made in an early issue of The Journal.

THE ANNUAL MEETING IS AT HAND

By the time this number of The Journal reaches many of its readers the thirty-ninth Annual Meeting will be under way, with every promise of being one of the most successful of the Society's conventions.

Coming at a time when world peace promises to be an early reality and when engineers will be called upon to lead in the readjustment of industry to peace conditions, this meeting assumes even greater importance than the war conventions at Cincinnati, New York and Worcester which have preceded it. These were the largest, most enthusiastic and most significant meetings ever held by the Society and predicate still greater success for the one that is about to be held.

Among the broader problems to be dealt with during the period of reconstruction is that of labor, or human relations in industry. With rare foresight the Committee on Meetings and Programs planned last spring for an all-day session at the Annual Meeting on the Engineering of Men. This will be the subject of the Keynote Session, which will be addressed by some of the foremost authorities in the country.

In view of the important work of standardization undertaken by the Congressional Screw-Thread Commission, a session will be devoted to Screw Threads and Screw-Thread Gages, with contributions by representatives of the British Engineering Standards Association, the National Physical Laboratory, our own Bureau of Standards, and the Congressional Commission.

At the opening session on Tuesday evening President Main's address will be given—on the Broader Aspects of the Work of the Engineer; and the Secretary is pleased to announce that on the same evening Honorary Memberships will also be conferred on Messrs. Charles M. Schwab and Orville Wright.

Besides the usual business, with reports of Standing and Special Committees, etc., at the first morning session, there will be an important preliminary report by the newly formed Committee on Aims and Organization, with representatives from each of the Sections and from the Society at large.

On Wednesday and Thursday evenings there will be illustrated lectures of the greatest interest on the engineering work of the Army and Navy in the war. A luncheon will be held on Wednesday noon, with an address by George W. Kirchwey on a Message from the Legal Profession.

Besides these features there will be various entertainment features, excursions, luncheons, etc., tea and entertainment for the ladies, and an opportunity for dancing. Members and guests from other cities are cordially invited to join with the New York members in these events.

The following is a list of the papers to be presented, besides which there will be several addresses:

For presentation, Wednesday morning, December 4

Report of Committee on Standardization of Flanges and Pipe Fittings

For presentation, Wednesday afternoon, December 4

The British Engineering Standards Association, C. le Maistre

Work of British Engineering Standards Association on Screw Threads and Limit Gages, Sir Richard Glazebrook

Present Practice in Thread-Gage Making, F. O. Wells

The Measurement of Thread Gages, H. L. Van Keuren

Standards for Large Taper Shanks and Sockets, L. D. Burlingame

Refrigerating-Plant Efficiency, Victor J. Azbe

For presentation, Thursday morning, December 5

Industrial Organization as It Affects Executive and Workers, C. E. Knoeppel

Non-Financial Incentives, R. B. Wolf

For presentation, Thursday afternoon, December 5

Employment of Labor, Dudley R. Kennedy

Labor Dilution as a National Necessity, Frederick A. Waldron

Intensive Training, C. R. Dooley

Properties of Airplane Fabrics, E. D. Walen

Industrial Power Problems, W. F. Uhl

Daylight vs. Sunlight in Sawtooth-Roof Construction, W. S. Brown

Factory Stairs and Stairways, G. L. H. Arnold

The Weights and Measures of Latin America, Frederick A. Halsey

Efficiency and Democracy, H. L. Gantt

For presentation, Friday morning, December 6

The Conservation of Heat Losses from Pipes and Boilers, Glen D. Bagley

Chemical and Physical Control of Boiler Operation and the Application of Simple Formulae for Estimating the Heat-Loss Items, etc., E. A. Uehling

The Cooling Losses in Internal-Combustion Engines as Affecting Design, C. A. Norman

Discussion of Certain Problems in Regard to Marine Diesel Oil Engines, J. W. Anderson

Valves and Fittings for High Hydraulic Pressures, W. W. Gaylord

The Relative Corrosion of Alloys, R. B. Fehr

The Relative Corrosion of Cast-Iron, Wrought-Iron and Steel Pipe in House-Drainage Systems, Wm. P. Gerhard

Determination of Stresses in Wire Rope as Applied to Modern Engineering Problems, J. F. Howe

Mechanical Features of the Vertical-Lift Bridge, Horatio P. Van Cleve

A STUDY OF ENGINEERING EDUCATION

REPORT BY DR. CHARLES RIBORG MANN[1]

IN 1907 the Society for the Promotion of Engineering Education invited the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Chemical Society to join it in the formation of a joint committee to examine into all the branches of engineering education. The next year the Carnegie Foundation for the Advancement of Teaching was invited to appoint delegates to the committee, and subsequently the Carnegie Foundation undertook to carry out the work on a large scale, and selected Dr. Charles R. Mann to make a careful investigation and report. The committee has kept in close association with Dr. Mann during the progress of the work.

Dr. Mann's researches have been published by the Carnegie Foundation in a special bulletin of 138 pages. They have also been published rather extensively in the September issue of the *Bulletin* of the Society for the Promotion of Engineering Education. Both accounts have been consulted in preparing this abstract.

Dr. Mann's report is divided into three parts. The first part states what present practices and conditions are, and describes the situation that needs analysis. It treats of the development of the engineering schools in the United States, their early history and the aims and curricula of the old schools. Because of the failure of the engineer to recognize that engineers could be trained in school, the engineering schools had to overcome many obstacles before they were acknowledged by the profession. Up to that time engineers had been merely trained by the apprenticeship method.

This part also deals with the changes of curricula from the beginning to the present time, and discusses the methods of administration in engineering schools, faculty control, student elimination and progress. It then takes up types of instruction in engineering schools, and indicates briefly some of the common practices in teaching the standard or fundamental subjects such as physics, mathematics, chemistry and English.

The second part discusses the problems of engineering education.

The development of entrance requirements has been away from the control of individual judgment and toward a system of committee control, as is evidenced by the creation of the College Entrance Examination Board. In order to indicate how entrance tests could be developed and what reliance could be placed on them, a series of experiments were made for the Carnegie Foundation by Professor Thorndike, of Columbia University.

Attention is directed to the fact that the current practice in making curricula is for the faculty to discuss only the time to be allotted to each subject, and not the degree of skill an engineer is expected to acquire in that particular subject.

In regard to the question of testing and grading, it is pointed out that an objective test, in which every one must agree to its finding, is a real measure of achievement; whereas the current methods are subject to the fallacies of individual judgment, because every department sets its own examinations and passes its own judgment.

Special consideration is given to the problem of shopwork. The original type of shopwork was merely to send the boy out to observe what was going on in shops. Later, the idea was to make the boys build something salable. At present the common plan in most of the schools is to teach the physical manipulations required in the fundamental shop operations without insisting on the acquisition of any construction experience.

There is also the type, developed at the University of Cincinnati, where the boys spend half of their time in a real shop, doing production work for pay, and the other half in school, discussing the problems which they have discovered in the shop.

No judgment is passed on the relative merits of these plans, but the question is raised as to whether the scheme where the students spend part of their time in a real industrial plant, there meeting the real problems of industry and thence carrying them back to the school for discussion, does not offer a clew to a fruitful solution of the shopwork problem.

The third part of the report suggests solutions of the problems that have been discussed.

It is recommended that the number of credit hours per week be less than eighteen, preferably sixteen, in order that the students may do their work more thoroughly. Also, in constructing a curriculum, it is suggested that the number of simultaneous courses be limited to four or five at the outside.

The adequate provision in the first two years for contact with real engineering projects and the interrelation between the concrete and the abstract are considered as essential in all engineering curricula.

The report advocates that the first step in framing a course of study is to define the common basis of all engineering as clearly as possible; that is, to make a list of all the facts, principles and processes that are essential elements in the equipment of every engineer. Theoretically this is the plan on which present curricula are founded, for they all have a common core made up of three distinct parts, namely, science (mathematics, chemistry, physics and mechanics), mechanic arts (drawing and shop), and the humanities (English and foreign languages). All of this common core is usually explicitly required of every student, no matter what specialty he may choose.

In the current organization of the common core of all engineering, however, the report recognizes no inherent or intrinsic relationships among the three categories under which the classification is made, and indicates that in designing curricula, the fundamental aim of engineering should be kept in mind. There must be actual participation in real industrial work; there should be engineering laboratory work, including drawing and descriptive geometry; mathematics and science should be developed systematically in logical order so as to furnish the backbone of the course; and the instruction in the humanistic studies should be presented with a view to develop skill in expression, interest in literature, and an appreciation of the human relation involved in engineering.

Throughout the entire course a great deal of attention must be paid to the testing and sorting of the men. Testing and sorting processes were in a very vague state a year or two ago. But an enormous amount of experience is being developed and collected at the present time by the efforts of the War Department to test and sort men for the Army mobilization. The Department now has psychological laboratories for testing all the men in two of the camps. They have personnel officers in all of the camps, and the work is making rapid progress. An enormous amount of information as to the meaning of these tests and their validity in sorting out ability is being gathered and digested and trade tests are being devised to pick out specific ability for certain lines. The results of their investigations as to valid methods of using objective tests will be of importance in selecting students for admission to engineering schools and in sorting young men during the first year or two of their course, so as to decide whether a boy ought to go into the civil engineering or some subhead under civil engineering, or into mechanical or electrical engineering. In other words, the experiences with the students in their common work that extends over two or three years should be utilized not only to train the man's ability to know and do things, but also as a means of vocational guide to select men and steer them, in the latter part of their course, into the special lines of work for which they are fitted. So the latter part of the course will be made up of large groups of specialties. Those who have been selected by the first two or three years' work as qualified for civil engineering will be put in a group where for the next year or so they will deal first with all the materials of civil engineering not included in the first two years, but which are essential to all the sub-specialties of civil engineering. Then they will proceed from that into some particular specialty.

The report recognizes that the teacher is the crux of the situation, and that the present organization of universities is not well qualified to encourage teachers to experiment and undertake

[1] Professor of Education and Director of Educational Research, Massachusetts Institute of Technology; Director of Committee on Education and Special Training, War Department.

the sort of investigation that is going to be necessary in order to put the suggested plan into operation. Hence it recommends that an organization be made at the school for the purpose of studying the teaching problem, and the school and faculty recognize at the start that it is some business of the professor of physics what the professor of mathematics is doing; and it is some business of the professor of electrical engineering what the professor of chemistry is doing. With such an organization in existence, a spirit of coöperation will be developed among the faculty. The professor of mathematics, for example, if he goes into it in the right spirit, instead of feeling that his interests have been sorely trampled upon when the professor of physics or engineering presumes to tell him what they want done, will find his work in mathematics has become enormously more inspiring to him and to the students. It will engender good feeling of the very best sort and result in a release of creative energy among the whole faculty. Thus conditions will be developed at the schools that will make the teachers want to study their problems together, instead of those which discourage the undertaking of anything that is not according to an established practice.

The system in vogue in the universities to make research work and the publication of the results of research the measure of success and the criterion of promotion for teachers, is pertinently criticized in the report. In this connection it says:

It is unquestionably true that research, as at present treated, does interfere seriously with teaching. Hundreds of college instructors whose interests lie in the human problems of education, rather than in the material problems of natural science, are now being diverted from a study of the teaching problem and induced to undertake research because academic promotion so obviously depends on the latter. Many a young man with promise of making an excellent teacher is sidetracked by the requirements for the Ph.D. degree and becomes instead, a mediocre researcher. Yet though much that is done under the name of research is but pseudo-research, the university is clearly right in its position that the spirit of investigation is an essential factor of university life.

The difficulty does not lie in research itself, but in the limitations that still cling to the common interpretation of it. Because research has been developed in the field of natural science and has wrought such marvels there, its activities have unconsciously been thought of as restricted to the problems of the material world. Because the technique of research and the units and methods of measurement have been so perfected in the domain of natural science that great accuracy and definiteness of conclusion are now possible, the early struggles for objectively defined standards and scales have been forgotten. Hence it seems to many grotesque to talk about research in education and the impersonal measurement of the vaguely defined and elusive qualities of human beings. The fact that such measurements have as yet been rather crude and inconclusive is no reason against trying to improve them, especially now when the greatest need of education is a technique and a terminology that will make the results of experiments in teaching intelligible to every one. . . .

If university trustees, presidents, and faculties will unite in insisting on a scientific study of their educational work, they will create the conditions needed to release teaching power in the engineering schools. The professors who have teaching interest and ability will welcome the opportunity to win recognition in work that arouses their enthusiasm and stirs their imagination to creative effort just as the professors who are interested in natural science have responded to the opportunity to promote research. This should not result in a diminution of output in research, but in a decided increase, because it tends to give each man the work he is best fitted to do, and therefore leads ultimately to maximum efficiency.

An understanding of the spirit of Dr. Mann's study and the line of reasoning which has led to his conclusions is obtained from the part of his report entitled The Professional Engineer. He remarks in explanation of the purpose of his work:

The statement that individuality counts for as much as learning for the engineer, just as it does for the lawyer or the physician, seems like a veritable platitude. Yet because the engineering schools have always made it their chief aim to impart the technical information needed in industrial production, and because both scientific knowledge and industrial practice have grown so rapidly, the attention of technical schools has been focused chiefly on keeping up to date in science and practice. The university emphasis on research in natural science has also tended to magnify the importance of technique and to minimize the importance of personality; until curricula have become so congested with specialized courses that students generally regard literature and sociology as unnecessary chores, to be endured rather than enjoyed. Therefore it seemed necessary to consider the question whether this emphasis on technique is producing a new and higher type of engineer, or whether the engineering profession still stakes its faith on the fundamental thesis that personal character is, after all, the real foundation for achievement.

To arrive at the requirements of the engineering profession, circular letters were sent to engineers throughout the country, asking them what they deemed the most important factors in determining probable success or failure in engineering. The result of their replies, in which personal qualities were numbered seven times as frequently as knowledge of engineering science and the technique of practice, was sent to the thirty thousand members of the four large engineering societies, and each was asked to number six groups of qualities headed respectively character, judgment, efficiency, understanding of men, knowledge, and technique, in the order of importance which he gave them in judging the reasons for engineering success and in sizing up young men for employment and promotion. Their votes placed the character group at the head of the list by a majority of 94.5 per cent, while technique was voted at the bottom by an equally decisive majority.

Thus it appears that there is a keen appreciation of the importance of the personality of the engineer. Dr. Mann thinks that recent events have brought out that need still more clearly.

Further in this part he summarizes the situation as follows:

The ultimate aim of engineering education has always been and still is more intelligent industrial production. Technical schools were founded when industrial evolution had progressed so far as to create a pressing demand for men who knew how to utilize the new and rapidly expanding knowledge of natural science to increase and improve production. Science was then little taught in high schools and colleges, so that both the public and the manufacturers were ignorant of it. Under these conditions the obvious need was for scientific enlightenment; and this the engineering schools were organized to supply . . .

The schools . . . . have thereby contributed enormously to the achievement of two striking results; namely, the extension of science instruction into the school system generally, and the development of public recognition of engineering as a profession, coördinate with theology, medicine, and law. At the present day an encouraging fraction of the people are reasonably intelligent in science, the worker in applied science has become socially respectable, and there has been developed a large conception of the engineering profession. Meanwhile the methods of dealing with the material problems of industry in a scientific way have been in a measure established, while the more intricate problems of organizing and managing men are rapidly pressing forward and demanding engineering treatment.

The net result is that the curricula and methods of instruction that were devised to supply the intellectual element in production by imparting knowledge of natural science must be recognized to meet the new industrial demand for engineering administrators and the larger professional demand for men of strong personality. The general plan of the proposed reorganization is based upon an analysis of engineering practice into its three essential factors; namely, knowledge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs. In every engineering project the overlapping claims of these three essential factors must be harmonized with respect to the two fundamental elements of production, namely, materials and men. Surely every engineer should have some conception of the present conditions and problems in at least the general aspects of all these essential factors and elements. If this be granted, it is easy for any school to discover where its curriculum is overloaded and where it is deficient.

This analysis also indicates how the present organization of school work can be modified so as to furnish a more vital training for professional engineers. Thus, with regard to materials, the schools do give careful instruction in the laws of physical science and in the properties and uses of materials. Students are taught the relative strengths of substances in the materials laboratory, kinematics teaches the principles of gearing, the shapes of gear teeth are worked out in the drawing room, the chemical properties are taught in chemistry, mechanics deals with the forces required to overcome inertia, machine work is relegated to the shop, and so on. But seldom is all this information coördinated in a single practical problem, such as determining whether mild steel, nickel steel, or phosphor bronze is the best thing to use in making a particular gear wheel; nor is the student ever asked to judge what combination is likely to produce the most valuable result for the price. Yet this balancing of value and cost is the controlling factor in all intelligent production.

. . . . An adequate treatment of the first element in production involves not only a scientific presentation of the laws of nature and the properties of materials, but also an estimation of the values and costs from both the material and the human points of view. The chasm between the school and practical life is due largely to a failure to appreciate this fact. The introduction of the study of values and costs in all their phases is the most direct method by which the schools can bridge this chasm. Such study is also one of the most potent means of liberating creative energy and of developing the spirit of investigation.

REPORTS OF STANDING COMMITTEES OF ADMINISTRATION

THE reports of Standing Committees of Administration[1] of The American Society of Mechanical Engineers will be presented at the forthcoming Annual Meeting as an appendix to the Annual Report of the President of the Society's activities for the year. The reports are published below.

Report of Finance Committee

The Finance Committee reports that the income of the Society for the year ending September 30, 1918, was $240,086.70. After reserving $15,000.00 for obligations undertaken but not yet completed, the total expenditures chargeable to income were $223,701.21, leaving an excess of income over expenditures of $16,385.49.

Based on a membership of 8720, the average of the total membership on October 1, 1917, and that on October 1, 1918, the average income of the Society per member for the fiscal year just closed is tabulated below. The corresponding income for the preceding year is included for comparison.

AVERAGE INCOME PER MEMBER

	1916-17.	1917-18.
Membership Dues	$14.57	$14.06
Sales—Gross Receipts	1.90	1.61
Advertising	8.42	9.31
Interest and Discount	.62	.50
Initiation Fees (one-half)	.90	1.02
	$26.41	$26.50

One-half of the initiation fees are put into reserve each year, so that the figures given above represent that portion.

Based on the same average membership, the expenditures of the Society per member for the fiscal year just closed are also given below, together with the corresponding expenditures for the previous year for comparison.

AVERAGE EXPENDITURES PER MEMBER

	1916-17.		1917-18.	
Meetings, Annual and Spring		$1.39		$1.41
Publications:				
Journal	$9.01		$7.29	
Condensed Catalogues			2.19	
Transactions	1.75		2.22	
Year Book	.68		.79	
		11.44		12.49
Membership and Increase of Membership		1.37		2.09
Office Administration		2.85		3.00
Upkeep of Headquarters		.32		.32
Employment Bulletin		.27		.33
Government Employment Work		.19		.20
United Engineering Society:				
Assessment to U. E. S.	.85		.55	
Library	.53		.46	
Engineering Council	—		.42	
		1.38		1.43
Local Sections		1.06		1.59
Council Contingencies, Mileage		.56		.52
Student Branches		.16		.07
Cost of Publications, Pamphlets, etc.		1.08		.99
Engineering Committees:				
Standardization, Research, Boiler Code, Screw Threads, etc.		.45		.93
Other Activities		.23		.28
Total		$22.75		$25.65
Additions to Building.				

The Budget Appropriation recommended by this Committee and approved by the Council for the year 1918-1919 is as follows, being 87 per cent of the estimated income:

Finance Committee:		
Office Administration	$26,100	
Occupancy of Building and Engineering Council	8,800	
Library	4,800	
		$39,700
Membership Committee		5,000
Council:		
Contingencies	3,500	
Committees not otherwise provided for	9,200	
Mileage	2,500	
Employment Bulletin	3,500	
		18,700
Sections Committee		13,500
Increase of Membership Committee		10,000
House Committee		5,650
Meetings Committee		12,750
Publication Committee		117,000
Research Committee		2,000
Students' Committee		1,000
Junior and Student Prizes Committee		75
Sales Expenditures		9,500
John Fritz Medal Board of Award		75
Engineering Resources Committee		800
Public Relations Committee		500
Total		$236,250

In addition, $10,000 was aproved by the Council, to be taken from surplus, for initiation of the Engineering Index.

The estimated income for the year 1918-19 is $270,730.

Appended will be found reports of the accounts of the Society as shown in the books for the fiscal year ending September 30, 1918.

DEATH OF MR. ROBERT M. DIXON

At a special meeting of the Finance Committee of The American Society of Mechanical Engineers held November 7, 1918, the following resolutions were adopted on the recent death of Mr. Robert M. Dixon, an honored member of the Society for the past thirty years and Chairman of the Finance Committee more than eight years:

Whereas, it has pleased an Allwise Providence to remove from us our fellow member and leader, therefore be it

Resolved, That in the death of Mr. Robert M. Dixon, for ten years a member of the Finance Committee and for more than eight years its Chairman, the Society has lost one of its most valuable members and the Finance Committee a leader whose wise counsels and mature judgment contributed in a most conspicuous manner to the present sound financial condition of our Society, which is in itself a most flattering tribute to the financial and executive ability of the Engineer, the Citizen and lovable companion whose loss we mourn.

And be it further Resolved, That a copy of these resolutions be spread upon the minutes of this meeting, and a copy properly amplified with historical data be engrossed for presentation to Mr. Dixon's family, and for publication in THE JOURNAL and TRANSACTIONS of the Society.

Respectfully submitted,

GEORGE M. FORREST, *Chairman*,
THEO. STEBBINS,
ALFRED FORSTALL,
W. E. SYMONS,
Finance Committee.

REPORT OF ACCOUNTANTS

FINANCE COMMITTEE,
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

DEAR SIRS:

In accordance with your instructions, we have examined the books and accounts of The American Society of Mechanical Engineers for the twelve months ended September 30, 1918.

The results of this examination are set forth in the three exhibits attached hereto, as follows:

Exhibit A Balance Sheet, September 30, 1918.
Exhibit B Income and Expenses for the twelve months ended September 30, 1918.
Exhibit C Receipts and Disbursements for the twelve months ended September 30, 1918.

We certify that, in our opinion, the accompanying Balance Sheet is a true exhibit of its financial condition as of September 30, 1918, and that the attached statements of Income and Expenses, and Receipts and Disbursements, are correct.

Respectfully submitted,

(Signed) WM. J. STEUSS & CO.,
Certified Public Accountants.

EXHIBIT A

BALANCE SHEET, SEPTEMBER 30, 1918.

ASSETS

Equity in Society's Building (No. 25 to 33 West 39th Street)	$365,846.62	
Equity in one-third of Cost of Land (No. 25 to 33 West 39th Street)	180,000	
		$545,846.62
Library Books	13,000.00	
Furniture and Fixtures	5,000.00	
		18,000.00
Stores, including plates and finished publications		28,861.39
Trust Fund Investment:		
New York City 3½'s, 1954 (par $45,000)	39,696.81	
St. L., Peoria & N. W. 1st 5's, 1948 (par $10,000)	10,613.89	

[1] Owing to the restrictions placed by the War Industries Board, Paper and Pulp Division, on the use of paper, only the reports of the Standing Committees of Administration are being printed this year.

Trust Fund Investment (Continued):		
United New Jersey Canal Co. (par $1,000)	$970.00	
Cash in Banks representing Trust Funds	4,789.93	
		$56,070.63
City of East Orange, Loan Certificate.		21,371.95
Liberty Bonds		30,000.00
Accounts Receivable:		
Members' Dues	13,879.73	
Initiation Fees	8,682.50	
Sales of Publications, Advertising, etc.	41,573.00	
		64,135.23
United Engineering Society, Loan		15,000.00
Advance Payments		4,745.65
Cash: In Banks for General Purposes	23,489.14	
Petty Cash on hand	500.00	
		23,989.14
		$808,020.61

LIABILITIES

Trust Funds:		
Life Membership Fund	$45,874.57	
Library Development Fund	4,902.71	
Week's Legacy Fund	1,957.00	
Melville Fund	1,127.36	
Hunt Memorial Fund	208.99	
Juniors' and Students' Prize Fund	2,000.00	
Total		$56,070.63
Dues paid in advance		2,546.14
Initiation Fees uncollected		8,682.50
Replacement Fund		1,163.18
Accounts Payable		4,140.53
		$72,602.98
Unexpended Appropriation 1917-1918	15,780.79	
Unappropriated Revenue	15,604.70	
		31,385.49
Capital Investment	551,346.62	
Surplus and Reserve	152,685.52	
		704,032.14
		$808,020.61

EXHIBIT B

INCOME AND EXPENSES FOR THE TWELVE MONTHS ENDED SEPTEMBER 30, 1918

INCOME

Membership Dues	$122,608.13	
Sales—Gross Receipts	14,076.88	
Advertising	81,207.27	
Interest and Discount	4,339.17	
Initiation Fees	17,855.25	
Total		$240,086.70

EXPENSES

Finance Committee:			
Office Administration	$26,175.83		
Occupancy Building	4,800.00		
Engineering Council	3,999.97		
Library	3,600.00		
		38,575.80	
Membership Committee		5,281.49	
Council:			
Contingencies	3,211.24		
Mileage	1,335.85		
Committee Miscellaneous	7,524.67		
Employment Bulletin	2,908.69		
		14,980.45	
Increase of Membership Committee		12,969.69	
House Committee		3,935.75	
Sections Committee		13,887.51	
Meetings Committee		11,119.03	
Publication Committee:			
Advertising	39,754.09		
Journal Text	42,023.86		
Revises	289.90		
Transactions	19,357.72		
Year Book	6,879.56		
Engineers' Index	606.47		
		108,911.60	
Sales Expenditures		8,968.36	
Research Committee		258.69	
Students' Committee		671.73	
Junior and Student Prizes		48.52	
John Fritz Medal		34.69	
Engineering Resources		$1,758.75	
Public Relations		7.91	
Unexpended Appropriation 1916-1917		2,291.24	
[1]Total			$223,701.21
Excess of Income over Expenses			$16,385.49

EXHIBIT C

RECEIPTS AND DISBURSEMENTS FOR THE TWELVE MONTHS ENDED SEPTEMBER 30, 1918

RECEIPTS

Membership Dues	$116,883.99	
Initiation Fees	35,710.50	
Membership Dues paid in advance	3,087.45	
Sales of Publications, Badges, Advertising, etc.	90,387.35	
Interest	6,039.17	
Liberty Bond Account	1,603.80	
United Engineering Society	2,500.00	
	256,212.26	
Cash on hand and in banks, General and Trust Funds, September 30, 1917	36,901.15	
		$293,113.41

DISBURSEMENTS

Disbursements for General Purposes	$226,834.34	
Liberty Bonds	20,000.00	
United Engineering Society	17,500.00	
	264,334.34	
Cash on hand and in banks, General and Trust Funds, September 30, 1918	28,779.07	
		$293,113.41

Report of Committee on Meetings and Program

As the financial year of the Society does not correspond with the calendar year, it becomes necessary for this Committee to consider two general meetings in retrospect and one in prospect, yet of the former, only one was planned for by the Committee as now constituted.

The Annual Meeting held in December 1917 was the largest in the history of the Society in point of registration. The total number was 1965, of which 1115 were members and 850 guests. The number of members exceeded the registration at the Annual Meeting of 1915 by 88.

Because of the unsettled conditions due to the war activities of so many of our members, the 1917 Annual Meeting was given over to a larger number of addresses than usual and to fewer professional papers. However, the established practice of holding a keynote session was followed, the topic being Service of the Engineer to the Public in Times of National Crises.

The Spring Meeting of 1917 held in Cincinnati broke all previous Spring-Meeting records in regard to attendance, but the high record was again surpassed at the Worcester meeting of this year, the total registration being 986, of which number 472 were members and 514 guests. These numbers compare with 868, 410 and 458 respectively, the record at Cincinnati.

These increasing numbers in attendance at our meetings are significant of the broader field of activity that our Society is entering.

The situation brought about by the few papers offered for the Annual Meeting of 1917 existed at the time of the Spring Meeting of this year. But during the past few months a decided change has taken place in this particular. At the September meeting of your Committee not only was there a prospect of many more professional papers than can be presented in December, but nearly enough papers were ready for final approval at that time. It is possible that this change is an evidence of the stimulating effect of the war, which we are told has had a remarkable influence upon British engineering literature.

SOME FEATURES OF THE 39TH ANNUAL MEETING

Four features of the forthcoming December meeting deserve mention. A year ago an innovation was introduced into the program by providing for a luncheon at which time an address was given by Professor Dexter S. Kimball. A similar luncheon is planned for the forthcoming Annual Meeting, and at the request of the newly appointed Committee on Aims and Organization, that Committee has been given the privilege of providing the speaker and selecting the topic of his address.

The keynote session will have for its general theme Engineering of Man Power.

A joint session with the Society of Refrigerating Engineers has been scheduled. A part of the professional papers will be supplied by each society. Your Committee has been very willing to enter into this arrangement, which is in keeping with the Society's general policy

[1] NOTE: The item of total expenses includes $15,000 not yet paid, to complete work already in process and chargeable to this year's activities.

of maintaining close coöperation with other engineering organizations.

The fourth feature for the Annual Meeting that should be mentioned here is the giving of a prominent place on the program to the Committee on Aims and Organization, namely, that period of the session on Wednesday morning immediately following the regular business meeting of the Society.

Work of the Sub-Committees

The work of the sub-committees of the Committee on Meetings and Program has, in the main, been exceedingly satisfactory. Without seeming to single out any one of these before another, it is a pleasure to acknowledge the unbroken record of successful sessions planned for by the Textile Sub-Committee under the chairmanship of Mr. Charles T. Plunkett.

The activities of the Sub-Committee on Protection of Industrial Workers having assumed more of the character of a special committee, the Committee recommended to the Council that the status of this committee be changed to that of a special committee. The recommendation was accepted.

The Committee favors a policy of appointing temporary sub-committees to investigate specific matters and assist in preparing special parts of the program of the meetings. However, it has not had opportunity to put this plan into full effect.

Acknowledgment

To an increasing degree during the past year the Committee has submitted professional papers to members of the Society who are especially conversant with the topics discussed, in order to have their opinions when the papers were considered for final disposition. It is a pleasure to acknowledge the uniform cordial coöperation that all of these requests for assistance and advice have evoked.

Respectfully submitted,

L. P. Alford, *Chairman*,
John W. Upp,
Dexter S. Kimball,
A. L. De Leeuw,
William G. Starkweather,
Meetings and Program Committee.

Report of Publication and Papers Committee

The chief development of the Society's publications during the past year has been the establishment in The Journal of a comprehensive indexing of engineering periodical literature with particular reference to mechanical engineering subjects. This feature is one that has been consistently advocated by the Committee for many years and in fact was first proposed by the original committee appointed by the Council to report upon the establishment of The Journal. The actual accomplishment of the index feature has only awaited the time when it was felt by the Council that the Society was in a position to undertake it.

Coincident with this development, there has been under consideration an offer by the publisher of *Industrial Management* to sell its long-established Engineering Index, the purchase of which the Publication Committee now recomends to the Council. It is believed by the Committee that the indexing of engineering articles can best be accomplished by a professional organization, such as ours, through the facilities afforded by our magnificent library, which regularly receives over 1000 periodicals from all parts of the world. The purchase of the Index would bring to The Journal the prestige, name and other rights and privileges of what has been regarded as the leading index in the field, and establish this as a Society activity on a secure and non-competitive basis.

The addition of the index feature to The Journal brings this publication to as large a size as can advantageously be handled in monthly issues. Further increases to make The Journal more valuable to the profession will necessitate more frequent publication. Such development, however, must obviously be left until industrial conditions return to normal.

In compliance with the wishes of the War Industries Board that the tonnage of paper required for periodicals be curtailed, The Journal will for the present use a larger type page with more closely spaced type.

The annual volume of Transactions has been issued as usual with no material change, except that the subject matter has been influenced by the engineering work which so many of our members are doing in connection with the war.

There has been a considerable gain in the size and comprehensiveness of the annual volume of Condensed Catalogues for the current year. Four hundred and fifteen firms, including a majority of the leading manufacturers in their respective lines, are represented in its pages of catalogue data. The directory section has been extended and improved and to the mechanical engineering data section there has been added a subject list of Transactions papers, beginning with the first volume issued in 1880. The compiling and printing of this list was considered desirable, because the Society has not yet been able to issue the comprehensive index to Transactions which the Committee has several times recommended and for which the preparation of the index cards was completed two years ago. It is strongly urged by the Committee that this index be issued as soon as conditions allow.

At the last Spring Meeting, certain changes in the Constitution of the Society were effected, one of which designates this Committee as the "Publication and Papers Committee." In this connection, it is interesting to note that the Publication Committee was originally responsible for the approval of the papers which were to be presented at the Society's meetings, and printed in its Transactions. In 1904, the Committee on Meetings was organized to relieve the Publication Committee of certain of its burdens in respect to meetings, and since then the main function of the Publication Committee has been to pass upon papers referred to it by the Committee on Meetings and more lately also by the Local Sections Committees for use in the Society's publications. The Publication Committee has taken no initiative in procuring papers.

The obvious intent of the constitutional change is to express the desirability of the Publication and Papers Committee taking up the solicitation of papers and contributions for the publications. The Committee respectfully requests that By-Laws be formulated with respect to this function and expressing a clear policy for the handling of papers both for general and Sections meetings and for publications.

The past year has been most successful financially, the gross income from advertising having exceeded $81,000. The financial statement covering the Committee's activities will be found in the report of the Finance Committee.

Respectfully submitted,

George A. Orrok, *Chairman*,
J. W. Roe,
H. H. Esselstyn,
George J. Foran,
Ralph E. Flanders,
Publication Committee.

Report of the Membership Committee

The Membership Committee held twenty-four meetings during the year 1917-1918, as against nine during fiscal year 1916-17.

The number of applications considered in the transaction of its work and a summary showing the action taken follow:

Applications pending October 1, 1917	863
Applications received during the fiscal year	1901
Total	2764
The following action was taken on these applications:	
Recommended for membership	1769
Recommended for membership (special cases)	36
Deferred indefinitely	20
Deferred	42
Denied promotion	13
Remission	8
In regular course of procedure	844
Foreign deferred for period of war	32
Total	2764
Reinstatements and reconsiderations pending	30

Those recommended for membership were divided into the following grades:

Members	486
Promotion to Member	60
Associates	104
Promotion to Associate	2
Associate-Members	575
Promotion to Associate-Member	64
Juniors	478
Total	1769

The Membership Committee has been most careful in the scrutiny of applications and no names of candidates have been recommended to the Council unless they are citizens of the United States or of one of the Allies. Action on application from foreigners has been deferred until the conclusion of hostilities.

Respectfully submitted,

Hosea Webster, *Chairman*,
S. D. Collett,
Frederick A. Waldron,
W. S. Timmis,
R. F. Jacobus,
Membership Committee.

Report of Committee on Local Sections

At the Spring Meeting of the Society in Worcester, May, 1918, a Constitutional Amendment was passed which changed the status of the Committee on Local Sections from a Special Committee to a Standing Committee of Administration and to one of the six Fundamental Committees of the Organization of the Society.

Your Committee has held the following meetings during the year:

DATE	PLACE
October 11, 1917	Philadelphia
November 28, 1917	Philadelphia
January 8, 1918	New York
February 11, 1918	New York
March 12, 1918	New York
April 15, 1918	New York
May 13, 1918	New York
July 18, 1918	New York
August 28, 1918	Philadelphia

By-Laws Governing Sections

At its October meeting the Committee reviewed the final revision of the proposed By-Laws governing Local Sections and recommended them to the Council for adoption. They were subsequently adopted and now appear as B-48 and B-49 in the By-Laws.

These By-Laws have since been published in THE JOURNAL and the following Sections have now adopted constitutions and by-laws in conformity with them: New York, Indianapolis, Minnesota and Birmingham.

Sections Meetings

During the active season, upwards of 120 meetings were held by the various Local Sections. At a large proportion of these the speakers discussed subjects of interest in the winning of the war.

Finances

The Committee on Local Sections was apportioned a sum of $10,750 for its year's expenses, and this the Council augmented in May 1918 by an additional grant of $3,500. The total expenditures for the year amount to $13,887.51.

New Sections

At its October 1917 meeting your Committee received a petition for the establishment of a section for the State of Connecticut with branches at Bridgeport, Hartford, Meriden, New Haven and Waterbury, the New Haven Section being merged in the new State Section and becoming a branch of it, a type of Section developed in coöperation between the Connecticut members and your Committee. The petition was referred to the Council, which approved it.

At its August 1918 meeting your Committee received a petition from Cleveland, Ohio, and this was referred to the Council, which approved it.

At this time local Sections are in process of formation, notably at Pittsburgh, Washington, etc.

Your Committee is continually endeavoring to carry the Local Sections idea into territories which are strong in membership and in activities, and with that object in view is watching its opportunity to spread the gospel of organization in all centers of the country not now included in the already organized Local Sections of the Society.

Coöperation of Sections Committee with Other Committees

In coöperation with the Publications and Papers Committee of the Society your Committee recommended to the Local Executive Committees the appointment of Local Papers Committees. The purpose of these committees is to secure papers for presentation at the meetings of the sections and for forwarding to the Publication and Papers Committee for possible publication in THE JOURNAL and for presentation at General Meetings and inclusion in Transactions.

Similarly in coöperation with the Research Committee, your Committee recommended to the Local Executive Committee appointment of sub-committees on Research to ascertain what researches were being carried on or contemplated in the industrial laboratories and in the institutional laboratories in the territory of the Sections.

To date a number of the Sections have appointed sub-committees for both these purposes.

In coöperation with the Membership Committee your Committee is considering ways and means of fostering relations with local societies by means of some plan of joint membership in the National Society and the Local Society. The petition received from the Cleveland Section especially asked this Society to see what could be done to provide such joint memberships, and in accepting this petition the Council obligated itself to consider a practical plan.

In coöperation with the Meetings Committee your Committee arranged for a Session at the Annual Meeting in December, 1917, to be conducted by the Committee on Local Sections. Unfortunately, however, the program of the meeting was so full that very little time could be given to this innovation and it resolved itself into a conference of the Local Sections delegates.

Visits by the Committee and by Officers to the Sections

Beginning October 21, 1917, your Committee visited the Sections at St. Louis, Milwaukee, Chicago and Detroit. The November, 1917, meeting of the Committee was followed by a visit to the Philadelphia Section. An invitation to visit Birmingham was received with thanks and the Committee hopes to take advantage of this within the near future.

It was suggested that it would be well to develop a scheme to take care of visits by officers to the Sections by arranging visits to those Sections located in the part of the country in which the officers reside.

Nominating Committee

In accordance with a suggestion received from President Main, your Committee had a report prepared on the various methods in vogue with other engineering societies of selecting nominees for elective offices, and it devised a plan of placing the selection of the Nominating Committee into the hands of the membership by having it consist of delegates elected by the Sections. This plan was outlined in a report submitted to you by your Committee. The Council referred this matter to the Committee on Constitution and By-Laws, which proposed an amendment to the Constitution so as to provide for the election of said Nominating Committee by the Society membership in place of the present practice, leaving the formulation of all details in connection with this election to the by-laws which it will submit presently to provide for the selection of the Nominating Committee through the machinery of the Sections.

Conferences of Delegates

An important conference of delegates of the Sections was held in New York, December, 1917, in connection with the Annual Meeting, and this was reported in full in the January 1918 issue of THE JOURNAL.

Delegates were present from Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Connecticut, Erie, Indianapolis, Milwaukee, Minnesota, New Orleans, New York, Philadelphia, Providence, St. Louis, San Francisco and Worcester.

A conference of delegates was also held in connection with the Spring Meeting at Worcester, June, 1918, and reported in the July JOURNAL.

Joint Meetings

During the Summer plans were laid to hold a joint meeting of the Mid-Western Sections in the Fall in some Mid-Western city. In coöperation with the several Local Committees of these Sections the meeting was assigned to Indianapolis and the date fixed as October 25 and 26. The Council decided to meet in Indianapolis at the same time also and at the moment of writing this report the program of said joint meeting is almost completed.[1]

Your Committee hopes that this will prove to be the inauguration of a series of joint Local Section meetings.

Coöperation with Sections of Other Societies and with Local Societies

In San Francisco there has been formed the Joint Council of Sections of the National Societies and the San Francisco Section of our Society participated in this movement. The purposes of the new organiation have been published in the technical press.

In Cleveland our new Section has been formed as the Mechanical Section of the Cleveland Engineering Society. This opens up a new field of coöperation between our Societies and local organizations and we look forward with open but conservative minds to the development of the Cleveland plan.

In many of the centers we have continued our coöperative plan as before. For example, in New Orleans we have coöperated effectively with the Louisiana Society; in Philadelphia we have continued our plan of coöperation with the Engineers' Club; in Chicago several joint meetings have been held under the auspices of the Western Society of Engineers, etc.

War Industries Readjustment Committee

President Main utilized the machinery of the Local Sections organization in appointing representatives of the Society's Committee on Readjustment of War Industries to coöperate with the Regional Committees of the Resources and Conversion Section of the War Industries Board. This Committee is issuing its own report.

Acknowledgment

The Committee desires to express its sincere appreciation of the coöperation of all the Local Committees and recommends that the thanks of the Council be extended to them for their efforts in furthering this important activity of the Society.

We also desire to record our special appreciation of the untiring energy and help which the Society's staff has at all times given to the Sections and our Committee.

Since the formation of our Committee four years ago, Mr. Ernest Hartford has acted as its Secretary and most acceptable have been his services; although we regret his withdrawal from these duties, we are

[1] The meeting was later postponed indefinitely on account of the epidemic of Spanish influenza.

glad that our government will have the advantage of his efficient help.

Respectfully submitted,

D. Robert Yarnall, *Chairman*,
Louis C. Marburg,
Walter Rautenstrauch,
Chas. Russ Richards,
H. B. Sargent,
Local Sections Committee.

Report of the Committee on Constitution and By-Laws

The Committee records with sincere regret the death on May 14, 1918, of its Chairman.

At its meeting on May 24 the Committee approved the following resolution:

> The Committee on Constitution and By-Laws of the American Society of Mechanical Engineers in parting with its Chairman, Frederick Remsen Hutton, realizes the great loss which it has sustained.
>
> The Committee will greatly miss his wise counsel, his broad vision, his high ideals, his genial bearing and friendship.
>
> The Committee desires to extend to his wife and family its very sincere sympathy in their great affliction.

The Council, at its meeting on October 12, 1917, referred to this Committee the question of the remission of the dues of members who entered the service of the United States for the war with Germany and also the question of the remission of the dues of persons who had been members of the Society for many years, with the view of amending By-Law 16.

The Committee, after careful consideration of the question, presented the following as a substitute for By-Law 16 at the meeting of the Council on November 16, 1917:

> B 16a. The Council may in its discretion restore to membership any person dropped from the rolls for non-payment of dues, or otherwise, upon such terms and conditions as it may at the time deem best for the interests of the Society.
>
> B 16b. The Council may in its discretion remit the dues of any member of the Society in any grade who is engaged in military or other patriotic service of the United States during the continuance of the war conditions and for a period thereafter.
>
> B 16c. The Council shall permanently exempt from dues any member of the Society who has paid dues for thirty-five years or who shall have reached the age of seventy years after having paid dues for thirty years.

This substitute was approved by the Council at its meeting on January 18, 1918, and went into immediate effect.

At the same meeting the Council approved a recommendation of the Membership Committee as follows:

> *Voted*, That the members who have honored the Society by entering the military service of the United States receive all privileges of their membership, and, upon request, may have current dues remitted.

The Council at its meeting on February 15, 1918, referred to this Committee an elaborate report of the Committee on Local Section, under date of February 11, on the Selection of Officers and Appointment of Nominating Committees.

This Committee gave very careful consideration to the whole subject and submitted to the Council at its meeting in Philadelphia on April 23, 1918, proposed amendments to sections 47 and 48 of the Constitution by which the Nominating Committee would be taken out of the list of Committees to be appointed by the President, and proposing a new form of C 48 to read as follows:

> C 48. There shall be one or more Committees to nominate candidates for the elective offices of the Society, as the By-Laws shall provide.

The Committee took the position that the Constitution should only provide for the fundamental establishment of Nominating Committees and that the details of the number of Committees, the number of members on each Committee, their tenure of office and the mode of their election should be provided for in the By-Laws, where they could be changed as conditions changed. The Council did not approve of the recommendation of this Committee and referred the matter back to the Committee.

This Committee again took the whole subject into consideration and submitted a report to the Council at its meeting in Worcester, Mass., on June 4, 1918.

This Committee proposed that C 47 be amended by striking out the words "A Nominating Committee appointed by the President" and amending C 48 so as to read as follows:

Nominating Committees

> C 48. There shall be a Nominating Committee whose duty shall be to select candidates for the elective offices to be filled at each election. This Committee shall be elected by the voting membership of the Society.
>
> Other Nominating Committees having the same power may be constituted by the voting membership.
>
> The number of members, the election, organization and procedure of all Nominating Committees shall be as the By-Laws shall provide.

These proposed amendments to C 47 and C 48 were approved at the same meeting by the Council after amending the proposed C 48 by inserting the word "annually" after "elected" in the second sentence.

These proposed amendments as amended by the Council were sent out in printed form to the membership as provided in C 57, by being published in the July issue of The Journal, page 53. This matter will come up for discussion at the Annual Meeting in December next.

Respectfully submitted,

Jesse M. Smith, *Chairman*,
Ira H. Woolson,
James E. Sague,
George M. Basford,
D. Robert Yarnall,
Constitution and By-Laws Committee.

AMONG THE LOCAL SECTIONS

The Annual Report of the Committee on Local Sections for the fiscal year ending September 30, 1918, is printed elsewhere in this issue. The report covers the subjects of by-laws, meetings, finances, new Sections, coöperation of Sections Committee with other committees, visits to the sections by officers, the selecting of the Nominating Committee, conferences of delegates, joint meetings, and coöperation with sections of other societies and local societies.

The report discloses that after only four years of operation the Committee on Local Sections has succeeded in establishing its work on the basis of intimate coöperation with the other committees of the Society, which the Committee thinks is just as essential as developing its own field of activities individually.

The relations of the Committee with the proposed Constitution and By-Laws changes are, in the matter of selection of the Nominating Committee, quite a fundamental change in the government of the Society, have been most satisfactory, and the Committee on Local Sections is justly proud in having taken part in the democratization of the Society by placing the power of appointing the regular Nominating Committee in the hands of the voting membership.

Members might be interested to know to just what extent the Committee on Local Sections carries out this plank of committee coöperation in its platform. At each of its meetings (as the annual report shows, frequent meetings were held during the past year) the committee sits down to a regular order of business, of which the following is a schedule:

Order of Business

1 Reading the minutes of the previous meeting.
2 Statement of condition of finances:
  (a) Main committee
  (b) Local committees
3 Sections' Officers:
  (a) Recording of new officers of local committees
  (b) Confirmation of changes in local committees
4 Actions of Council and committees affecting Local Sections Committee:
  (a) Council
  (b) Meetings and Program Committee
  (c) Publication and Papers Committee (Sections' Sub-Committees on Papers)
  (d) Research Committee (Sections' Sub-Committees on Research)
  (e) Employment Department
  (f) Membership Committee
  (g) Increase of Membership Committee
  (h) Constitution and By-Laws' Committee.
5 Sections' By-Laws, Rules and Records:
  (a) Proposed amendments to By-Laws
  (b) Progress of adoption of By-Laws
  (c) Record books.
6 Report of Sections organization development:
  (a) Important developments in existing Sections centers

(b) Developments in connection with Sections petitions received
(c) Requests for Sections, and developments in centers where Sections are desirable.
7 Sections coöperation with local organizations of other societies and with local societies.
8 Reports and requests from Local Committees.
9 Relations with Publication Committee:
(a) Technical Section of JOURNAL.
(b) Society Affairs Section of JOURNAL. . . . .
10 Deferred Business.
11 New Business.
12 Adjournment.

A glance at this order of business will show that it aims to cover not only the usual duties of such a coöperative committee as the Committee on Local Sections, but also to emphasize that this committee is subject at all times to the direction of the Council, and is but one factor in the organization of the Society.

In other words, the broad plan on which the Committee on Local Sections works is that while there is strength in an organization of committees assigned to definite tasks, the closest intercommittee relations are at the same time necessary for cohesion and for the development of a coördinate will.

The Committee on Local Sections urges all Section executive staffs to place before it their real problems and constructive criticisms; for through such an interchange of ideas are Society and professional unity and progress assured.

Section Meetings

ATLANTA SECTION

The members of the Atlanta Section were entertained at dinner by the Chairman of the Executive Committee of the Section, Mr. Robert Gregg, at the Druid Hills Golf Club, October 17. After the dinner a paper was presented by E. L. Brooks, Associate Member. Am.Soc. M.E., on the subject Uniform Boiler Code.

The speech was followed by a discussion on the advantage of having the A.S.M.E. Boiler Code adopted by the State of Georgia, and a motion was carried instructing the Chair to appoint a committee of four members to draft the proper bill to be presented to the next legislature.

WILLIAM J. NEVILLE,
Secretary.

BIRMINGHAM SECTION

On November 20, its anniversary day, the members of the Birmingham Section met for dinner in the rooms of the Civic Association. The dinner was followed by a general, informal discussion.

JAMES W. MOORE,
Secretary.

BOSTON SECTION

Mr. A. Douglas Wardrop, Managing Editor of *Aerial Age*, delivered a lecture before the members of the Boston Section on Saturday evening, November 9, the subject being his recent trip to France, and experiences on the fighting line.

The Section is now planning a meeting on the timely subject of Reconstruction.

The report of the October 17 meeting given in the last issue of THE JOURNAL was incorrect. The meeting was held on October 29, and the speakers were F. P. Fish of the General Electric Company, who spoke on the Elements of the Labor Problem. Mr. Fish gave a general résumé of the development of the labor situation both in this country and in England during the last few years. He pointed out the strength and also the weakness of the organized labor movement, and suggested ways in which the engineers could coöperate to alleviate some of the weakness.

Mr. W. E. Freeland, of the Winchester Repeating Arms Co., presented a paper entitled Government Activity Toward the Solution of the Labor Problem. He dealt specifically with the Bridgeport case, summarizing the work of the National War Labor Board there, and comparing the award made by this Board with the actual rulings of the examiner appointed by the Board.

Mr. Perry described the plan under which the Emergency Fleet Corporation was adjusting labor difficulties by means of shop committees.

WILLIAM G. STARKWEATHER,
Secretary.

BUFFALO SECTION

The A.S.M.E. Section of the Engineering Society of Buffalo conducted the meeting on November 27. The address of the evening was delivered by C. H. Bierbaum, on the subject of Bearings.

W. W. BOYD,
Secretary.

CHICAGO SECTION

A joint meeting of the Chicago Section of the A.S.M.E. and A.I.E.E. with the Western Society of Engineers was held in the rooms of the Western Society on Tuesday, November 12. The subject was Industrial Lighting and the War, and Professor C. E. Clewell, of the University of Pennsylvania, delivered an address, illustrated by lantern slides.

A joint meeting of the War Committee of Technical Societies of Chicago was held on November 25 in the rooms of the Western Society of Engineers. Fuel Conservation was the subject of addresses by Preston Millar and Harold A. Almert.

ARTHUR L. RICE,
Secretary.

CONNECTICUT SECTION

The fall meeting of the Connecticut Section was held at New Haven on November 20. The members assembled at the Mason Laboratory at 2:30 p. m. for a trip by automobile to the power plant of the Marlin-Rockwell Corporation and to the new central heating plant of Yale University.

Upon the return of the party a dinner was held at the Mason Laboratory, at 6 p. m., followed by a meeting at Lampson Lyceum, Yale University. The address of the evening was given by Mr. W. H. Blood, of the American International Shipbuilding Corporation, on the Building of Hog Island Shipyard, illustrated by slides and motion pictures.

The Winchester Engineering Club and the Yale University Student Branch of the A.S.M.E. participated in the evening session.

E. H. LOCKWOOD,
Secretary.

NEW YORK SECTION

Albert C. Ritchie, counsel for the War Industries Board and Attorney General of Maryland, spoke at a joint meeting of the New York Section and other technical bodies, held in the Engineering Societies Building, 29 West 39th Street, on November 20. He told of America's part in supplying steel for war needs of this country and the Allies, and predicted an unprecedented demand from Europe for reconstruction purposes.

J. Leonard Replogle, Director of Steel Supply of the War Industries Board, had been announced as the principal speaker of the evening, but J. E. Johnson, Jr., who presided, said that Mr. Replogle had been detained in Washington and delegated Mr. Ritchie to discuss the steel situation.

The speaker, after reviewing at length the achievements of the steel industry in the war, said that the War Industries Board would retain control hereafter over a given industry only when all interests asked for such supervision.

Captain P. E. Dulieux of the French High Commission said that immediate French requirements in the steel line called for 8,000,000 tons. He predicted that, with Alsace-Lorraine back in possession of France, his country might "at a not very distant date be your competitor."

Julius Kahn of Youngstown, Ohio, made an address on the larger uses of reinforced concrete in building operations of the immediate future.

H. D. EGBERT,
Secretary.

PHILADELPHIA SECTION

A meeting of the Philadelphia Section was held at the rooms of the Engineers' Club on November 26. J. F. Johnson of the Westinghouse Electric & Manufacturing Co. delivered an address on Large Steam Turbine Design.

J. P. MUDD,
Secretary.

PROVIDENCE ENGINEERING SOCIETY

On November 5, at the Society's rooms, a joint meeting was held, Mr. C. J. Carter of Boston giving an informal talk on Gas Engines for Sea Sleds before the Machine Shop Section. The Power Section was entertained by Talks on Coal—its Production, Distribution and Storage.

The speakers of the evening were Mr. L. D. Moore, Superintendent of Castner, Curran & Bullitt, Inc.; Professor W. H. Kenerson, Director of Conservation for the Rhode Island Fuel Administration, and Mr. A. N. Sheldon, of F. P. Sheldon & Sons, Mill Engineers.

Mr. A. Douglas Wardrop, Managing Editor of Aerial Age, delivered the address on November 8, at Memorial Hall, the subject being My Flight Over the Hindenburg Line, and Latest Developments in Aerial Warfare.

Mr. Edson F. Gallaudet, of the Gallaudet Aircraft Corporation, delivered an address before the Designing and Drafting Section on November 12, the subject being The Application of Some Principles of Airplane Design.

On November 19, Major F. B. Gilbreth, Mem.Am.Soc.M.E., delivered an interesting lecture on the mechanical action of the new designs of Lewis and Browning machine guns, illustrating his lecture with moving pictures of the parts in action.

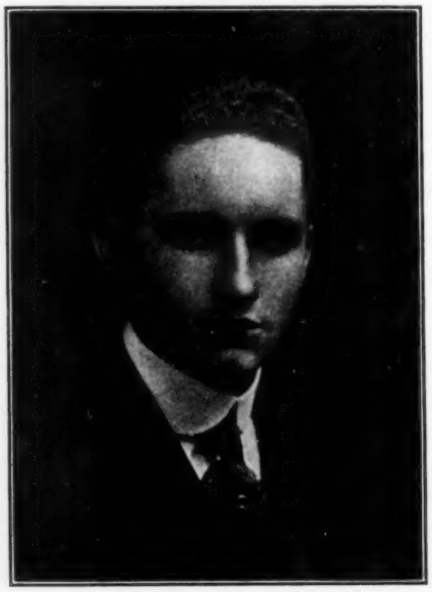
The Chemical Section heard an interesting address on Some Problems of Gas Warfare by Prof. E. B. Spear, of Massachusetts Institute of Technology.

WILLIAM A. KENNEDY,
Secretary.

NECROLOGY

WALTER ANTOSCH

Walter Antosch was born in New York City on March 17, 1896. He attended the city schools and later Stevens Institute of Technology, from which he was graduated in 1917 with the degree of M.E. For about six months after his graduation he was connected with the Standard Aircraft Corporation, Elizabeth, N. J., serving first in the drafting room, then in the engineering department and finally as asssitant superintendent in the production department, where he had charge of routing material through the shops. He resigned his position at the end of that time and enlisted in the United States Naval Reserve Force and was assigned to the Naval Engineering School, where in a very short time he won the rating of machinist. He was then assigned to the U. S. S. *Westbridge*, which was torpedoed on August 15, when he was instantly killed. He was buried on August 28 in the Kerfautras Military Cemetery, Brest, France.



WALTER ANTOSCH

Mr. Antosch also served in the recent Mexican border trouble and was at that time connected with the First Field Hospital of the New York National Guard. He became a junior member of the Society in 1918.

SERGEANT ARTHUR HENRY BERGES

Arthur H. Berges was born on July 28, 1886, in Burlington, Iowa, and was educated in the schools of that city, later attending Purdue University, from which he was graduated in 1910 with the degree M.E. His first employment was with the Chicago & Northwestern Railway Co., Chicago, Ill., as special apprentice. In the early part of 1911 he became connected with the International Harvester Co., and had charge of the production in the tractor works, Chicago. His next position was with the H. W. Schott Co., engineers in Chicago, where his duties gave him charge of construction on the power house of a hydroelectric proposition at Ballville, Ohio. For a short period in 1913 he worked in the mechanical department of Sargent & Lundy, an engineering firm in Chicago, leaving to become draftsman in the shop-engineering department of the Chicago and Western Indiana Railroad Co. At the outbreak of the war he was employed as mechanical draftsman in the Rock Island Arsenal, Ill. He resigned from this position to enlist in the 23rd U. S. Engineers. He was killed in action in France on September 13, 1918.

Sergeant Berges became a junior member of the Society in 1914.

GEORGE GOODWIN CALDWELL

George G. Caldwell was born on June 22, 1857, in Peoria, Ill. He was educated in the public schools of Michigan and at Olivet College, Olivet, Mich. He served an apprenticeship as machinist with the Benjamin & Fischer Co., Chicago, Ill., from 1878 to 1880 and then worked for the next five years in various shops in Massachusetts and Rhode Island, gaining general experience on the construction of steam engines and boilers. About 1890 he became engineer for the Calumet Electric Street Railway Co., Chicago, and installed its plant. Subsequently he went into business for himself as construction engineer. From 1907 to 1909 he was connected with the Wheeler Condenser & Engineering Co., Chicago, erecting and operating machinery. In July, 1910, he entered the employ of H. M. Byllesby & Co. as construction superintendent on installations covering buildings and general power-plant machinery, and remained in that capacity except for a short interim until his death, July 27, 1918. While in this position he had complete charge of the installation of important works for the Oklahoma Gas & Electric Co., Oklahoma City, Okla.; the Northern State Power Co., Minot, N. D.; the Union Light, Heat & Power Co., Fargo, N. D.; the Interstate Light & Power Co., Galena, Ill., and the Ottumwa Railway & Light Co., Ottumwa, Ia.

Mr. Caldwell became an associate member of the Society in 1916.

STANLEY SHIELDS COOKE

Stanley S. Cooke was born on August 9, 1893, in Denver, Col., and was educated in the public schools there. He attended the University of Colorado and was graduated in 1915 with the degrees of B.S. and M.E. Upon graduation he was connected for short periods with the following firms: the American District Steam Co., Tonawanda, N. Y., on steam-heating main installations; the Denver Gas & Electric Light Co., Denver, Col., in the transformer department, repairing irons and fans and testing transformers; the Union Pacific Railroad Co., as special apprentice in the motive-power and construction department. He worked for about a year for the Union Metallic Cartridge Co., Bridgeport, Conn., and then took a position with the Lake Torpedo Boat Co., in the same city, on the construction of submarines.

Three weeks after our declaration of war he enlisted in the Navy Coast Guard Service and was sent to Fort Trumbull, New London, Conn., for training and afterwards assigned to the cutter *Tampa*, which left in October to engage in patrol and ascort duty in European waters. In June of this year Mr. Cooke was made first gunner and in August appointed coxswain, and the following month received orders directing his transfer to the Naval Academy to attend the Officers' Training School. On the night of September 26, however, while the *Tampa* was in the British Channel doing escort duty with the fleet, a violent concussion was felt but the cause was not then ascertained. Upon reaching port it was discovered that the *Tampa* was missing. Destroyers immediately set out to hunt for the vessel but apart from a little wreckage, some life preservers marked *Tampa* and two bodies in uniform, nothing else was discovered. The *Tampa* during her year's service abroad had made eighteen trips between Gibraltar and English ports and may be said to have rendered a real service to the Allied cause.

ARTHUR H. BERGES

LIEUTENANT PAUL HENRY CORDES

Lieut. Paul H. Cordes, who was killed in action on the western front in France on September 12, 1918, was born in Altona-Hanover, Germany, on February 17, 1887. He came to this country when he was about eleven years old and was educated in the public schools, later attending evening school, where he took the technical course.

In 1906 he became associated with the Henry R. Worthington Co., Harrison, N. J., works of the Worthington Pump & Machinery Corporation, where he was assistant to the superintendent of the erecting department. His duties there gave him charge of the erecting and testing work on steam and centrifugal pumps, surface condensers, etc. He also assisted in the supervision of the outside construction work. In 1913 he was transferred to the Chicago office as engineering salesman, assisting and having charge of the testing work on large triple-expansion pumping engines, centrifugal pumps and condensers, as well as making experimental and research tests of such machinery, which position he was holding at the time of his enlistment, May 1917. He held the rank of First Lieutenant in Company C, 30th Engineers, Gas and Flame Division.

Lieutenant Cordes became an associate member of the Society in 1916.

SAMUEL AMBROSE FRESHNEY

Samuel A. Freshney was born in January, 1867, in London, England. He was brought to this country when but a child and the family settled in Ohio. His first work was in connection with the electrical business when he was employed by the Brush Electric Co., Cleveland, Ohio. He spent his apprenticeship in the shops of this company and was then promoted to the engineering department. After seven years' service he left to become manager of the Electric Light & Power Co., Muskegon, Ill., where he remained until 1900. For the next two years he was branch manager of the Wayne Electric Works at Cincinnati, Ohio, and Grand Rapids, Mich. In 1902 he was made general manager of the Muskegon Traction & Lighting Co., operating street railway, electric and gas properties, and continued in that capacity until 1905, when he was offered and accepted the position of secretary and general manager of the Grand Rapids Board of Public Works, where he had charge of the water works, electric-light systems, public improvements, streets, sewers, flood protection, etc. In 1912 he resigned from the Board of Public Works to become general manager of the Consumers Power Co., Grand Rapids, Mich., which position he held up to the time of his death, September 16, 1918.

Paul H. Cordes

Mr. Freshney became a member of the Society in 1913.

MAJOR WILLIAM R. KING

Major William R. King, Ordnance, U. S. Army, died at the Post Hospital, Army Proving Ground, Aberdeen, Md., July 18, 1918. A military funeral was held at the Post on the morning of July 20 with the full honors due to his rank and service amid the surroundings which so fully typified his brief but most useful military service.

Prior to the entrance of the United States into the European War, Major King had been an active advocate of preparedness and published an article, A National Factor of Safety, in the *Engineering Record* of January 20, 1915, one of the first comments on the indispensable function of the engineer in modern war and the duty of technical schools to teach military engineering.

Major King was graduated from Stevens Institute of Technology with the class of 1886 and was chairman of the special committee which organized the battalion of 400 Stevens alumni and students in the Preparedness Parade, May 13, 1916. Later he was chairman of the Stevens Alumni Military Committee, placing 250 mechanical engineers in the reserve and civilian service. He, himself, applied for a commission on March 22, 1917.

On October 6, 1917, he was selected for the exceptional duty of Chief of Design and Construction of the new Army Proving Ground at Aberdeen, with its great variety of structures—railroads, highways, docks, power plant, machine shops, gun emplacements, ammunition storehouses and dwellings. He had supervised the erection of a part of the permanent structures and completed much of the temporary work at this proving ground when, on July 17, he was informed of prospective transfer to command at another proving ground and of recommendation for his promotion to the rank of Lieutenant Colonel. Early in the evening of the same day Major King was shot in his room by a man who had apparently no motive except a fancied grievance. The wound proved fatal in twenty-four hours.

William R. King

The following is a record of his principal engineering responsibilities: His first important position was that of assistant superintendent with R. Hoe & Co., New York City, 1886 to 1890; from 1890 to 1894 he was manager and engineer of the Empire State Phosphate Mining Co., an interest of Cooper Hewitt & Co. in Florida; he was next consulting engineer of companies developing respectively an air brake and the King Wyatt resistance type of electric furnace, 1894 to 1897; from 1897 to 1901 he was superintendent and manager of construction of the Oxnard Construction Co., erecting the beet-sugar factories at Oxnard, Cal., at Ames, Neb., and at Rocky Ford, Cal. Thereafter, from 1901 to the time of the war his work was in the field of hydraulic engineering; in particular, the electric plant of the Stanislaus River in California, the Klickitat River development in Washington and the irrigation and electrification projects of the Northern Pacific Railroad Co.

Major King became a member of the Society in 1914.

FRANK E. GETTS

Frank E. Getts was born in Fort Wayne, Ind., in June, 1870, and was educated in the public schools there. From 1887 to 1892 he served his apprenticeship as machinist in the Wabash Railway Shops, Fort Wayne, and for the next three years was connected with the Fort Wayne Electrical Works, first as electrical apprentice and later as construction foreman. His next position was with the Siemens & Halske Electric Co., where he had charge of building and installing electrical generators. He was also with the Northwestern Elevated Railway Co. for a short while. When he became associated with the Chicago Edison Co. in 1903 he was given charge of the installation of all steam turbines at the Fisk Street Power Station. The success of this work was due in great measure to Mr. Getts' personal efforts and his engineering ability. From 1910 to 1913 he had direct charge of all steam work for the General Electric Co. in the Middle West. In October 1913 he resigned from that company to become general manager of the Chicago office of the Alberger Condenser & Engineering Co., and in April 1915 he became general manager of the Electrical Engineers Equipment Co., Chicago, which position he held at the time of his death, May 7, 1918.

Mr. Getts was a member of the American Institute of Electrical Engineers, the Electric Club and the Press Club, Chicago. He became a member of our Society in 1913.

HARRY SHELDON LEONARD

Harry S. Leonard was born on October 21, 1865, in Washington, D. C. He was educated in the public schools of that city and later attended Yale University, from which he received in 1886 the degree of Ph. B. He was connected for about eight years with the New Haven Wire Manufacturing Co. as manager and then spent about a year with the Trenton Iron Co., Trenton, N. J., as sales manager. For the next three years he conducted his own business in Boston as a manufacturers' agent. In 1899 he became manager of the Boston office of the Westinghouse Electric & Manufacturing Co., leaving that firm to become associated with the Winchester Repeating Arms Co., New Haven, Conn., where he remained till about a year ago, when ill health compelled him to resign from the vice-presidency of the company with which he had been connected for eighteen years.

Mr. Leonard became a member of the Society in 1916. He died in New York City on July 26, 1918.

ALBERT THEODORE LEONHARD

Albert T. Leonhard, secretary of the Paterson Parchment Paper Co., Passaic, N. J., died on September 29, 1918, a victim of Spanish influenza.

Mr. Leonhard was born on March 4, 1887, in Haledon, N. J. He attended high school in Passaic and later Stevens Preparatory School from which he went to Stevens Institute of Technology, receiving his M.E. degree in 1908. He became associated in the same year with the Paterson Parchment Paper Co., where he designed and supervised the construction of paper-making and other machinery, improved old and devised new processes for the manufacture of paper; he also designed and supervised the construction of new mill buildings and had general charge of the mechanical department. At the time of his death he held the position of secretary of the firm.

Mr. Leonhard became an associate member of our Society in 1916.

DALE McCARTY

Dale McCarty was born in Gosport, Ind., on January 19, 1892, was educated in the public schools there and later attended Purdue University, from which he received the degree of M. E. in 1911. Upon graduation he worked for a short period with the Western Electric Co., Chicago. In September, 1911, he became connected with the Santa Fe Railroad Co., Chicago, where his duties consisted of steel detailing, layouts, freight and steel passenger-car designs, inspection of material and sketching of foreign-design cars. In the early part of 1914 he resigned from this position to become draftsman with the Enterprise Railway Equipment Co. His work there in the drafting room called for steel hopper, ore, steel and composite ballast, and drop-bottom gondola car designs, stress diagrams and estimates of weight having to be prepared for all cars designed. As mechanical representative of the company he had charge of the general inspection and oversight of deliveries of malleable and steel castings. He was also responsible for the inspection and approval of sample cars in conjunction with the representatives of railroads.

Mr. McCarty had expected to enter the Central Officers' Training Camp in January. He was stricken with Spanish influenza while on a business trip and died in Indianapolis, Ind., on October 18. He became a junior member of the Society in 1916.

WILLIAM EARLE MOSHER

William E. Mosher, who died of pneumonia in Washington, D. C., on October 12, was assistant superintendent engineer of the Army Transport Service, and had been recommended for a commission as Major in the Quartermaster Corps. He was born in 1888 and attended the schools of Mechanicville, N. Y. In 1909 he received the degree of Ph. B. from Syracuse University and in 1911 the degree of M. E. He then attended the Graduate School of the University of Illinois and obtained his M. S. in 1913, having specialized in refrigeration and thermodynamics. From September 1913 to June 1916 Mr. Mosher was assistant refrigeration technologist, U. S. Department of Agriculture, and had charge of the portable precooling plant. His next position was with the Fruit Dispatch Co., New York, as consulting engineer. In January 1918 he obtained leave of absence that he might offer his services to the Government.

Mr. Mosher was a member of the honorary societies of Phi Beta Kappa, Sigma Xi and Tau Beta Pi. He was also a member of the American Society of Refrigerating Engineers. He became a junior member of our Society in 1912.

CAPTAIN WALTER MARANTETTE WILHELM

Capt. Walter M. Wilhelm was born in Defiance, Ohio, on November 13, 1884. He was graduated from the United States Military Academy at West Point, N. Y., in June 1906, and from the School of Ordnance Engineering, Sandy Hook Proving Ground, in July 1909. In August of that year he became assistant and general superintendent at the Watervliet Arsenal, Watervliet, N. Y., the commanding officer being Col. W. W. Gibson. He was in charge of the operation of construction of field and coast guns, specializing in the subject of relining the latter type. He was also responsible for the installation of the Taylor System of manufacture at the Watervliet Arsenal. In 1913 he was transferred to Frankford Arsenal, Bridesburg, Philadelphia, where he was assistant to the officer in charge of the optical department dealing with the manufacture and design of sea-coast instruments. Later he became assistant to the officer in charge and then himself officer in charge of the artillery department at Frankford, where his duties gave him charge of the manufacture and design of shrapnel, shell, time and detonating fuses, hand grenades, rifle grenades, etc., used in the Army and Navy. In November 1915 he resigned from the Army to become vice-president and general manager of the Eddystone Ammunition Corporation, Eddystone, Pa., where he had full charge of the manufacture of 2,500,000 complete rounds of Russian shrapnel. He was holding this position at the time of his death, October 3, 1918.

Captain Wilhelm became a member of the Society in 1916.

ROLL OF HONOR

DIED IN THE SERVICE

Stanley S. Cooke, Coxswain, U. S. S. Tampa, U. S. Navy.

Paul H. Cordes, First Lieutenant, Company C, 30th Engineers, Gas and Flame Division, A. E. F., France.

The following list of those in the Service is made up of the names of members of the Society sent in during the month of November.

ALDEN, H. W., Lieutenant Colonel, Ordnance Department, U. S. Army; stationed at Washington, D. C.

ANDERSON, H. W., Private, Chemical Warfare Service, U. S. Army.

BABCOCK, F. R., Captain, Ordnance Department, U. S. Army.

BAYER, L. F., Coast Artillery Corps, U. S. Army.

BARBIERI, CESARE, Lieutenant, Royal Engineers, 2d Regiment, Italian Army, with the Italian High Commission, Washington, D. C.

BEEHLER, W. P., Commander, U. S. Navy; stationed at U. S. Naval Experimental Station, New London, Conn.

BEEKMAN, HENRY M., Second Lieutenant, Ordnance Department, U. S. Army; stationed at Sandy Hook Proving Ground, Fort Hancock, N. J.

BEERBAUM, ARTHUR J., Machinist's Mate, Second Class, U. S. Navy; Steam Engineering, Co. 5, Reg. 17, Great Lakes, Ill.

BIXBY, WILLIAM H., Brigadier General, U. S. Army (Retired); on War Service in U. S.

BLECKLEY, LOGAN, Private, 7th Service Co., Signal Corps, U. S. Army; assigned to Ellington Field, Houston, Tex.

BOEHNLEIN, C., Chief Quartermaster, Aviation Co. 31, Naval Aviation Detachment, Massachusetts Institute of Technology, Cambridge, Mass.

BOWEN, WILLIAM S., Second Lieutenant, Signal Corps, U. S. Army; stationed at School of Meteorology, College Station, Tex.

BOYLES, RALPH R., Private, 1st Co., 161st Depot Brigade, Camp Grant, Ill.

BRADLEY, E. P., Captain, Engineering Section, Construction Division, Quartermaster Corps, U. S. Army.

BRIZZOLARA, ROBERT T., Second Lieutenant, Aviation Section (Aeronautics), U. S. Army; stationed at Park Field, Millington, Tenn.

BROOKS, FREDERICK A., First Lieutenant, Air Service, Aircraft Production, American Expeditionary Forces, France.

BROWN, ARTHUR L., Captain, Engineering Division, Ordnance Department, U. S. Army.

BROWN, OWSLEY, Major, 172d Infantry, American Expeditionary Forces, France.

BRUBACK, T. M., Second Lieutenant, Research Division, Engineers' Corps, U. S. Army; stationed at Ellington Field, Tex.

BUCKINGHAM, J. E. E., First Lieutenant, Co. D, 87th Engineers, U. S. Army; assigned to Fort Benjamin Harrison, Ind.

BURKE, WALTER S., Lieutenant-Commander, U. S. Navy (Retired); stationed at U. S. Navy Yard, Boston, Mass.

BURSLEY, JOSEPH A., Major, Ordnance Department, U. S. Army.

CAMPBELL, E. GORDON, Captain, Engineers' Corps, U. S. Army.

CARTER, H. D., Captain, Ordnance Department, U. S. Army.

CARVER, E. M., Captain, Engineering Division, Ordnance Department, U. S. Army.

CHILDS, J. N., Lieutenant, U. S. Naval Reserve Force; stationed as Senior Engineer Officer, U. S. S. *Camden*.

Clancy, W. L., Ensign, U. S. Naval Reserve Force, Line of the Navy, Temporary Staff Duty, Aviation Division, Bureau of Construction and Repair, Washington, D. C.
Conner, B. F., Chief Machinist's Mate, U. S. Navy; stationed at the New York Navy Yard.
Cowles, Clifford A., Jr., Private, Second Class, 5th Service Com. Detachment, Signal Corps, U. S. Army; stationed at Gerstner Field, Lake Charles, La.
Cowperthwait, Allan, Major, Inspection Division, Ordnance Department, U. S. Army.
Cox, James W., First Lieutenant, Quartermaster Corps, U. S. Army.
Crook, W. Ralph, First Lieutenant, Construction Division, Quartermaster Corps, U. S. Army; stationed at Camp Holabird, Md.
Curtis, Allen, Captain, Spruce Production, Air Service, U. S. Army; stationed at Vancouver Barracks, Washington.
De Lany, E. H., Commander, U. S. Navy.
Devine, Charles P., First Lieutenant, Air Service, U. S. Army.
Dismukes, A. R., Co. B, Motor Transport Corps, Unit No. 305, U. S. Army; stationed at Camp Jessup, Atlanta, Ga.
Edwards, G. Middleton, Chief Machinist's Mate, Marine Engineers' Training School, Stevens Institute of Technology, Hoboken, N. J.
Estabrook, Charles B., Captain, Ordnance Department, American Expeditionary Forces, France.
Fischer, Louis A., Major, Gage Section, Engineering Division, Ordnance Department, U. S. Army.
Flewelling, M. F., Jr., U. S. Navy; assigned to U. S. Naval Steam Engineering School, Stevens Institute of Technology.
Fliegner, Carl G., Candidate, 10th Train Battery, Field Artillery Corps, Field Artillery Officers' Training School, Camp Taylor, Ky.
Flynn, John H., Captain, Conservation and Reclamation Division, Quartermaster Corps, U. S. Army; assigned to Camp Johnston, Fla.
Fusselman, P. A., Captain, Co. A, 314th Infantry, American Expeditionary Forces, France.
Gardner, Douglas M., Ensign, U. S. Naval Reserve Force.
Gardner, Thomas, Machinist, Naval Engineering School, Stevens Institute of Technology, Hoboken, N. J.
Garrison, W. L., Second Lieutenant, 301st Mobile Ordinance Repair Shop, American Expeditionary Forces, France.
Grobli, Walter A., Private, First Class, Detached Quartermaster Service, Medical Department, U. S. Army; assigned to General Hospital No. 12, Biltmore, N. C.
Grunert, Arthur E., Captain, Co. D, 4th Engineers, American Expeditionary Forces, France.
Grunwell, Paul C., First Lieutenant, Engineering Division, Ordnance Department, U. S. Army.
Hall, Charles A., Private, Provisional Post Headquarters Co., Training Detachment, Fort Benjamin Harrison, Ind.
Hawkins, Robert D., Lieutenant Colonel, Russian Railway Service Corps, U. S. Army; stationed at Harbin, Manchuria, Asia.
Hazzard, W. S., U. S. Navy; assigned to U. S. Naval Steam Engineering School, Stevens Institute, Hoboken, N. J.
Henszey, Joseph M., Major, Inspection Division, Ordnance Department, U. S. Army.
Hicks, George C., Jr., Major, Ordnance Department, U. S. Army.
Hider, George T., Private, Battery F, 36th Regiment, Coast Artillery Corps, U. S. Army; stationed at Camp Eustis, Va.
Hill, E. Logan, Captain, Engineers' Corps, U. S. Army.
Hill, Herbert M., Private, Science and Research Division, Air Service, Aircraft Production, U. S. Army; stationed at Carnegie Institute of Technology, Pittsburgh, Pa.
Hoopes, Edgar M., Jr., Captain, Utilities Detachment, Quartermaster Corps, U. S. Army; assigned to Camp Meade, Md.
Howard, Cecil D., First Lieutenant, Engineers' Corps, U. S. Army.
Hubbell, Richard L., Second Lieutenant, 109th Infantry, U. S. Army; stationed at Watertown Arsenal, Watertown, Mass.
Hunt, James L., First Lieutenant, Trench Warfare Section, Ordnance Department, U. S. Army.
Imeson, C. V., Captain, Construction Division, Quartermasters Corps, U. S. Army; assigned to Fort Barrancas, Fla.
Jackson, E. E., Private, First Class, Co. M, 22d Regiment Engineers, N. Y. Guard.
Jensen, James A., Second Lieutenant, Research Division, Chemical Warfare Service, U. S. Army; assigned to American University Experiment Station.
Johnson, George A., Major, Construction Division, Quartermaster Corps, U. S. Army.
Jones, Leon B., Candidate, Engineer Officers' Training School, Camp Humphreys, Va.
Kales, W. R., Captain, General Engineering Staff, American Expeditionary Forces, France.
Karcher, Harry E., Private, Co. A, 5th Training Battalion, Signal Corps, U. S. Army; stationed at Fort Leavenworth, Kan.
Kenyon, John T., Major, Ordnance Department, U. S. Army.
King, M. L., Major, Air Service, U. S. Army; stationed at Air Service Flying School, Post Field, Fort Sill, Okla.
King, W. G., Ensign, U. S. Navy.
Knight, Earl L., Sergeant, Co. A, 8th Battalion, Ordnance Department, American Expeditionary Forces, France.
Knox, Carlos C., U. S. S. *Carola IV*, U. S. Navy.
Kouwenhoven, Frank W., Private, Air Service (S.), U. S. Army assigned to Air Service School for Radio Operators, University of Texas, Austin, Tex.
Lunn, John A., Second Lieutenant, Engineers' Corps, Headquarters Services of Supply, Office of Chief of Chemical Warfare Service, American Expeditionary Forces, France.
Lyons, Karl M., Captain, Oil Branch, Fuel and Forage Division, Quartermaster Corps, U. S. Army.
McLaren, Lewis L., Private, Co. A, Fourth Training Battalion, Signal Corps, U. S. Army; assigned to Fort Leavenworth, Kan.
MacCart, R. D., Ensign, Naval Reserve Flying Corps; assigned to Massachusetts Institute of Technology, Cambridge, Mass.
Malone, J. G., Chief Machinist's Mate, Student, U. S. Naval Steam Engineering School, Pelham Bay, N. Y.
Maloney, Charles A., Ensign, Submarine Unit, New London Base, U. S. Navy; stationed at U. S. Naval Academy, Annapolis, Md.
Meeker, L. A., Captain, Gas Defense Division, Chemical Warfare Service, U. S. Army.
Mills, Harold H., Warrant Machinist, Naval Auxiliary Reserve, U. S. Navy.
Mitchill, George L., Corporal, Co. A, 302d Engineers, Headquarters 77th Division, American Expeditionary Forces, France.
Monahan, W. H., Jr., First Lieutenant, Inspection Division, Ordnance Department, U. S. Army.
Mott, C. S., Major, Quartermaster Corp, U. S. Army; Chief of Production, Detroit District Office.
Moxham, Egbert, Lieutenant Colonel, Ordnance Department, U. S. Army.
Muir, Leonard S., Second Lieutenant, Air Service, Aeronautics, U. S. Army; assigned to Wilbur Wright Field, Dayton, O.
Mullergren, A. L., First Lieutenant, Quartermaster Corps, U. S. Army; assigned to Camp Funston, Kan.
Nash, Douglas E., Ensign, Naval Aviation, U. S. Navy; stationed at Key West, Fla.
Naumburg, Robert E., Second Lieutenant, Air Service, U. S. Army; Engineer Officer First Reserve Wing, stationed at Hazelhurst Field, Mineola, L. I.
Nofsinger, L. E., Private, Air Service, U. S. Army.
Phillips, Leon R., Captain, Construction Division, Quartermaster Corps, U. S. Army.
Philpot, N. E., Chief Machinist's Mate, U. S. Naval Reserve Forces.
Porter, L. L., Ensign, U. S. Naval Reserve Force; stationed at U. S. Naval Academy, Annapolis, Md.
Pratt, Merrill E., Second Lieutenant, Coast Artillery Corps, U. S. Army; assigned to Coast Artillery School, Fort Monroe, Va.
Preston, R. A. D., Lieutenant, Bureau of Construction and Repair (Aviation), U. S. Navy.
Proctor, Redfield, Captain, Engineers' Corps, U. S. Army.
Prussing, R. E., Captain, Quartermaster Corps, U. S. Army.
Purdy, A. R., Private, Air Service, Aircraft Production, U. S. Army; assigned to Second Detachment, N. Y. City.
Roe, J. W., Major, Bureau of Aircraft Production, Air Service, U. S. Army.
Rouse, John E., Candidate, 13th Observation Battery, Field Artillery Corps, Officers' Training School, Camp Taylor, Ky.
Scott, T. Wayne, Sergeant, 111th Infantry, American Expeditionary Forces, France.
Seligman, W., First Lieutenant, Coast Artillery Corps, U. S. Army.
Seth, George L., Lieutenant, Chemical Warfare Service, U. S. Army.
Shepard, F. J., Jr., First Lieutenant, Engineering Division, Ordnance Department, U. S. Army.
Sherry, Samuel E., Jr., Chief Machinist's Mate, Sea-Plane Hangar Co., U. S. Naval Aviation; stationed at U. S. Naval Air Station, Rockaway, L. I.
Sinclair, A. F., Major, Ordnance Department, U. S. Army; stationed at U. S. Ammonium Nitrate Plant, Perryville, Md.
Smith, Cameron C., Major, Production Division, Ordnance Department, U. S. Army.
Smith, Victor J., First Lieutenant, Ordnance Department, U. S. Army; stationed at Frankford Arsenal, Philadelphia, Pa.
Solomon, Gabriel R., Major, Construction Division, Engineers' Corps, U. S. Army.
Spackman, Henry S., Lieutenant-Colonel, Engineers' Corps, American Expeditionary Forces, France.
Stinson, K. W., Second Lieutenant, Air Service (Aeronautics), U. S. Army; assigned to U. S. School of Military Aeronautics, Princeton, N. J.
Swain, Wilbur A., Candidate, 1st Co., Machine Gun Officers' Training School, Camp Hancock, Ga.
Tenkonohy, Franklin V., Captain, 301st Regiment Tank Corps, American Expeditionary Forces, France.
Thompson, John R., Captain, Engineers' Corps, American Expeditionary Forces, France.
Tuvin, J. H., Lieutenant, Utility Co., Construction Division, Army Base Hospital, U. S. Army; assigned to Camp Dix, N. J.
Wadd, Roy J., Second Lieutenant, Chemical Warfare Service, U. S. Army; assigned to Edgewood Arsenal, Edgewood, Md.
Walker, F. W., Jr., First Lieutenant, 4th Anti Aircraft Battalion, Coast Artillery Corps, American Expeditionary Forces, France.

LIBRARY NOTES AND BOOK REVIEWS

REVIEWS of books of special importance to mechanical engineers by members of the Society and those particularly qualified, brief descriptive notes of accessions to the Library of the United Engineering Society, items of interest relating to the Library's activities, etc.

AIRPLANE CHARACTERISTICS. A Systematic Introduction for Flyer and Student and for All Who Are Interested in Aviation. By Frederick Bedell. First edition. Taylor and Co., Ithaca, N. Y., 1918. Cloth, 6 x 9 in., 123 pp., 65 illus. $1.75.

The art of flying, the author states, has progressed so far that the principles of flying can in the main be set forth definitely, and a collection of the essential elements be made that will apply to all airplanes, irrespective of type or structure. He has therefore tried to present a codification of the well-known groundwork, which will give a direct, simple statement of the principles of airplane sustentation and stability and the characteristics of an airplane in flight. The present work only partially covers the subject, but has been issued in its present form to meet the need of the moment.

AMERICAN ASSOCIATION OF ENGINEERS DIRECTORY. Containing Lists of Members Arranged Alphabetically, Geographically and According to Professional Work. Corrected to July 1, 1918. American Association of Engineers, Chicago (copyright, 1918). Cloth, 6 x 9 in., 190 pp., 2 diag., 1 map. $2.

The directory contains an account of the history, aims and organization of the society, with lists of the members arranged alphabetically, geographically, and according to their professional experience.

THE AMERICAN HOSPITAL OF THE TWENTIETH CENTURY. A Treatise on the Development of Medical Institutions, both in Europe and in America, since the beginning of the Present Century. By Edward F. Stevens. Architectural Record Publishing Co., New York, 1918. Cloth, 7 x 10 in., 274 pp., 454 illus. $5.

Mr. Stevens presents plans of and information concerning a number of typical modern institutions, which show various solutions of the problems of housing and treating the sick. He adds also to his illustrations a summary of the results of his own experience in hospital construction and his study of European institutions.

THE ARBITRAL DETERMINATION OF RAILWAY WAGES. By J. Noble Stockett, Jr. Hougton Mifflin Co., New York, 1918. Cloth, 5 x 8 in., 198 pp. $1.50.

This volume of the Hart, Schaffner and Marx Prize Essays is a study of the principles of wage determination and of wage increase advanced by the employees and employers in the course of arbitration proceedings, with a view to ascertaining some fundamental principles which may serve as the basis of a fair and reasonable wage or of a just principle of wage increase. The arbitration proceedings examined number 65 and include those settled under the provisions of the Erdman Act and the Newlands Act, the railway cases under the Industrial Disputes Investigation Act, the Eastern Engineers' Arbitration of 1912 and the Western Engineers and Firemen's Arbitration of 1915.

THE BLUE BOOK OF FACTS OF MARINE ENGINEERING. Including new questions and problems with answers that are required for all grades of Marine and Gas Engine License. Third edition, revised 1918. Ocean Publishing Co., New York (copyright, 1917). Cloth, 4 x 6 in., 116 pp. $2.50.

This quiz compend gives the necessary information for obtaining marine engineers' licenses, in the form of questions and answers. These are classified according to the different grades of licenses.

BOMBS AND HAND GRENADES, BRITISH, FRENCH AND GERMAN. A Handbook Showing Their Construction and Technicalities, Giving Full Instructions as to How to Use and How to Render Useless. By Captain Bertram Smith. E. P. Dutton and Co., New York (copyright, 1918). Cloth, 5 x 8 in., 90 pp., illus., $2.

Descriptions of the types used by the different armies are given, with instructions for their use. Clear outline drawings of each type are included.

DESCRIPTIVE GEOMETRY. By William L. Ames and Carl Wischmeyer. Fifth edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 5 x 8 in., 112 pp., 197 illus. $1.

A condensed course for students in colleges of engineering, in which 72 problems are explained and illustrated, and 400 exercises for solution are presented. The book accords with drafting-office practice by using the third quadrant.

THE FLOTATION PROCESS. By Herbert A. Megraw. Second edition, revised and enlarged. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 359 pp., 74 illus., 1 pl., tables. $3.50.

Although litigation over patent rights still continues and there is still no agreement on the theory of the flotation process, the author has thought it advisable to issue a second edition of this work. In it the development of the process, both in theory and practice, is summarized, and an endeavor has been made to present as true a record of present conditions as is possible. Most of the original edition is retained, although some portions that later developments have made valueless are omitted, and considerable new matter has been added.

FUEL ECONOMY IN BOILER ROOMS. A Development of Fuel Economy and CO_2 Recorders Published in the Engineers' Study Course from Power. In two parts. Part I: Fuel Economy and CO_2 Recorders, by A. R. Maujer and Charles H. Bromley. Part II: Fuel Economy in Boiler Rooms, by Charles H. Bromley. Second edition. McGraw-Hill Book Co., Inc. New York, 1918. Cloth, 6 x 8 in., 308 pp., 92 illus., 18 tables. $2.50.

The volume before us contains a revised edition of the book formerly published as Fuel Economy and CO_2 Recorders with the addition of matter on other subjects of interest in connection with efficiency in power-plant operation. The authors have tried to provide a work that will explain in simple language the proper means of attaining fuel economy. For use by firemen and power-plant operating engineers.

GAGES, GAGING AND INSPECTION. A Comprehensive Treatise Covering the Limit System, Measuring Machines, and Measuring Tools and Gages for Originating and Comparing Measurements in the Manufacturing and Inspection Departments, Including Means for Measuring and Inspecting Screw Threads and Gears. By Douglas T. Hamilton. First edition. The Industrial Press, New York, 1918. Cloth, 6 x 9 in., 295 pp., 175 illus. $2.50.

This is the first book, the author says, which deals exclusively with the subject, describes the principles and practical application of the limit system of interchangeable manufacturing and the principal tools and gages in use, comprehensively enough to meet the requirements of today.

GEORGE WESTINGHOUSE. His Life and Achievements. By Francis E. Leupp. Little, Brown and Co., Boston, 1918. Cloth, 6 x 9 in., 304 pp., 5 pl., 6 portraits. $3.

In this account of George Westinghouse, the inventor and the man, the author has gathered his material from such contemporary sources as old newspapers and magazines, corporate reports, court records, local traditions and the personal recollections of the friends and neighbors of Mr. Westinghouse. The trials and failures of his early life, his perseverance in the struggle for the recognition of his air-brake, and his later successes are pictured in detail. The numerous personal anecdotes which are scattered through the book add greatly to the interest of the biography as a human document.

INTERPOLATION TABLES OR MULTIPLICATION TABLES OF DECIMAL FRACTIONS. Giving the Products to the Nearest Unit of All Numbers from 1 to 100 by 0.01 to 0.99 and from 1 to 1000 by 0.001 to 0.999. By Henry B. Hedrick. Carnegie Institution, Washington, 1918. Cloth, 10 x 14 in., 139 pp. $5.

These tables are of especial use in all problems involving the multiplication of decimal fractions of two or three digits where the product is required to no more significant figures than are contained in the smaller factor. Their use may be extended to decimal fractions of three and four digits. As the tables are more accurate than the slide-rule or graphical methods, and more convenient than logarithms, they are of value for many computations where those methods are ordinarily employed.

Life in a Large Manufacturing Plant. By Charles M. Ripley. General Electric Co., Schenectady, N. Y.

A series of pamphlets describing the systematic plans which have been developed for selecting an efficient working force for the General Electric Company and for maintaining a high physical, mental and moral standard.

MacRae's Blue Book. America's Buying Guide. Vol. IX., 1918. MacRae's Blue Book Co., Chicago (copyright, 1918). Cloth. 9 x 12 in., 1345 pp. (advertising pages included). $10.

This directory contains a list of thirty thousand American manufacturers of machinery, tools, and other supplies used by railroads and manufacturers, a list of manufacturers' representatives, a classed directory of makers of different products, an index of trade names, a collection of data useful to purchasing agents, tables of standard prices and a discount computer.

A Manual of Engineering Drawing for Students and Draftsmen. By Thomas E. French. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 329 pp., 556 illus. $2.50.

A method of instruction, based upon the conception of drawing as a language, with varied forms of expression, a grammar and style. New chapters on lettering, screw threads, bolts and fastenings, and structural drawing have been added; the chapters on working drawings and architectural drawing have been enlarged, and the text generally revised.

Mechanisms and Mechanical Movements. A Treatise on Different Types of Mechanisms and Various Methods of Transmitting, Controlling and Modifying Motion, to Secure Changes of Velocity, Direction, and Duration or Time of Action. By Franklin D. Jones. First edition. The Industrial Press, New York, 1918. Cloth, 6 x 9 in., 310 pp., 164 illus. $2.50.

The author has classified a variety of mechanical devices representing different types of mechanisms and illustrating important fundamental principles. He has also attempted not only to explain how various mechanical motions may be produced and controlled, but also to show the relation between the theoretical and practical sides of the subject.

Metallurgy of Lead. By H. O. Hofman. First edition. McGraw-Hill Book Co., Inc., New York., 1918. Cloth, 6 x 9 in., 664 pp., 705 illus., 1 folded pl., 153 tables. $6.

This work replaces the author's former treatise on The Metallurgy of Lead and the Desilverization of Base Bullion, but has been so largely rewritten and altered that it has become practically a new book. Only the chapters on reverberatory smelting and German cupellation have been retained in about their original forms. The author has prepared for the new edition by a careful review of the technical literature and by visiting the leading lead plants of the United States and Canada, and has attempted to represent modern practice thoroughly and accurately.

Methods of Measuring Temperature. By Ezer Griffiths. With an Introduction by E. H. Griffiths. Charles Griffin and Co., Ltd., London; J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6 x 9 in., 176 pp., 81 illus., 48 tables. 8s 6d.

This monograph, intended for those concerned with the measurement of temperature in scientific investigations or in the control of industrial operations, is chiefly devoted to the experimental basis of the methods in use, the calibration of the instruments and the precautions necessary in practice. The volume is intended to extend the general treatment given in standard textbooks and to be complete in itself. References to the important literature are given with each chapter.

Mine Tracks. Their Location and Construction. Treating briefly on the Materials Used and the Principles Involved in the Design and Installation, with a Set of Rules for a Standard Practice. By J. McCrystle. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible cloth, 5 x 7 in., 105 pp., 23 illus., tables. $1.50.

The adaptation of mechanical haulage and the successive increases in the weight of mine locomotives and rolling stock are making closer attention to mine tracks imperative, the author says. He has prepared this treatise to furnish a summary of the methods of several companies where systematic attention has been given to the subject, in convenient form for use by those responsible for the planning and maintenance of track work.

Modern Hot Water Heating, Steam and Gas Fitting. By William Donaldson. Frederick J. Drake and Co., Chicago (copyright, 1918). Cloth, 5 x 8 in., 256 pp., 11 illus., 30 tables. $1.50.

An elementary description of apparatus and methods of installing it.

Modern Management Applied to Construction. By Daniel J. Hauer. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 194 pp., 19 illus., 1 folded chart. $2.50.

Describes the application of the principles of scientific management to engineering and architectural construction, in the light of the author's experience. An appendix outlines the American and Canadian organizations for war construction.

The Motor Truck as an Aid to Business Profits. By S. V. Norton. A. W. Shaw Co., New York (copyright, 1918). Cloth, 7 x 10 in., 509 pp., 335 illus., 5 folded charts. $7.50.

A collection of plans for using motor trucks in various businesses, showing what has been accomplished in actual practice. The adaptation of the motor truck to a business, its effective and economical utilization, its maintenance and its part in developing the business are discussed in detail.

My Reminiscences. By Raphael Pumpelly. Henry Holt and Co., New York, 1918. Cloth, 844 pp., 57 pl., 24 por., 13 maps, 2 vols. 7.50.

Born in 1837, the author studied geology and mining engineering in Paris and Freiburg, and later led a busy life as a geologist, mining engineer and explorer for over half a century. His professional activities in Asia and America provided an abundance of information on these lands and many adventures and anecdotes, which are presented in an interesting fashion in this autobiography.

Operator's Wireless Telegraph and Telephone Handbook. A Complete Treatise on the Construction and Operation of the Wireless Telegraph and Telephone, Including the Rules of Naval Stations, Codes, Abbreviations, etc. By Victor H. Laughter. Frederick J. Drake and Co., Chicago (copyright, 1918). Cloth, 5 x 8 in., 191 pp., illus., 1 pl. $1.

A student's text, in which he is led from a study of simple elementary systems to the more complicated types of wireless telegraph and telephone instruments. Directions for the construction of instruments are given.

Plane Surveying. A Practical Treatise on the Art of Plane Surveying, Including Chaining, Leveling, Compass and Transit Measurements, Land and Construction Surveying, Topographic Surveying, and Mapping. By J. K. Finch. American Technical Society, Chicago, 1918. Flexible cloth, 5 x 7 in., 243 pp., 154 illus., 11 pl., 10 tables. $1.50.

This manual is especially intended for home study. It is planned to give the practical man a working knowledge of the subject, and to be used by trained surveyors as a convenient review.

A Practical Course in Wooden Boat and Ship Building. The Fundamental Principles and Practical Methods Described in Detail. Especially Written for Carpenters and other Woodworkers who Desire to Engage in Boat or Ship Building, and as a Text-Book for Schools. By Richard Van Gaasbeek. Frederick J. Drake and Co., Chicago (copyright, 1918). Cloth, 5 x 8 in., 204 pp., 119 illus. $1.50.

This text-book is the outgrowth of a course for shipbuilders given at Pratt Institute to assist house carpenters and other woodworkers in transferring from their usual occupations to the shipbuilding industries. The author has attempted to provide a brief, fundamental course in the general principles of construction.

Reinforced Concrete Construction. Part I. With Examples Worked Out in Detail for All Types of Beams, Floors and Columns. By M. T. Cantell, Mem.Am.Soc.M.E. Second edition. Spon & Chamberlain, New York, 1918. Cloth, 5 x 7 in., 160 pp., 75 illus., 1 pl.

The chief object in this work is to endeavor to meet the requirements of students, as well as others who have practical experience but only an elementary knowledge of mathematics and mechanics, for a simple practical treatment of the subject. Part I contains the principles, general information and examples of designing required by the majority of students and practical men. This

edition is revised to comply as far as possible with American and Canadian, as well as British, conditions and practice.

THE SECOND POWER KINK BOOK. A Collection of Short Articles from *Power* in Which Practical Men Describe Simple Expedients They Have Found Effective in Meeting Every-day Emergencies in Power-Plant Work. Compiled by the Editorial Staff of *Power*. McGraw-Hill Book Co., Inc. (sole selling agents), New York, 1918. One-half cloth, 6 x 9 in., 161 pp., 137 illus. $1.

The first Power Kink Book, published in 1917, has led to requests for a further collection of these notes on emergency power-plant practice, in response to which this volume is issued. The book, like its predecessor, is intended to suggest solutions for unusual problems and methods of meeting difficult situations.

SHEET METAL WORKERS' MANUAL. A Complete, Practical Instruction Book on the Sheet-Metal Industry, Machinery and Tools, and Related Subjects, Including the Oxy-Acetylene Welding and Cutting Process. By L. Broemel. With a Special Course in Elementary and Advanced Sheet Metal Work and Pattern Drafting for Technical and Trade School Instructors and Students; Also for Reference and Study by Sheet Metal Workers and Apprentices, by J. S. Daugherty. Frederick J. Drake and Co., Chicago (copyright, 1918). Flexible cloth, 5 x 7 in., 552 pp., 394 illus., 32 tables. $2.

The authors have tried to produce a comprehensive text-book on the machinery, tools and methods used in sheet-metal working, suited to the needs of manual training and trade schools. Outline courses in sheet-metal work and hand forging and welding which meet the requirements of emergency war training are included.

THE SHIPBUILDERS' BLUE BOOK. This is the first and only practical handbook containing such information as you must have in your daily work. It covers everything on Rivets and Riveting, Spacing of Rivets, Riveting for Water and Oiltight Work, Buttlaps, Buttstraps, Brackets, Frames, Plating, etc., by a Practical Man. By Walter Kay Crawford; edited by E. R. Glass. Ocean Publishing Co., New York, 1918. Cloth, 4 x 6 in., 79 pp. $1.50.

A compact manual of information useful to apprentices and shipfitters; largely in tabular form.

ACCESSIONS TO THE LIBRARY

ACIERS FERS, FONTES. Tome I. By Alexis Jacquet. *Paris, 1918.* Purchase.

AIRPLANE CHARACTERISTICS. By Frederick Bedell. *Ithaca, 1918.* Gift of author.

ALSACE-LORRAINE PROTESTS, translated from original French records and published by Mr. D. Fricot. *Angels Camp, Cal. n. d.* Gift of Alfred D. Flinn.

AMERICAN INSTITUTE OF MINING ENGINEERS. Transactions. Vol. 57, 58. *New York, 1918.* Purchase.

ASSOCIATION OF ONTARIO LAND SURVEYORS. Annual Report. No. 33, and Proceedings of 26th Annual Meeting. *Toronto, 1918.* Gift of Association.

BANGOR MINERAL DISTRICT. (Tasmania. Geological Survey, Bulletin No. 27). *Tasmania, 1918.* Purchase.

BANKING EVOLUTION. An address delivered by Chas. H. Sabin, President of the Guaranty Trust Co., before the State Bank Section of the American Bankers' Association, Sept. 25, 1918. Gift of Guaranty Trust Co.

BRITISH COLUMBIA. DEPARTMENT OF LANDS. Report of Water Rights Branch, 1917. *Victoria, 1918.* Gift of British Columbia Water Rights Branch.

BUILDING AND ORNAMENTAL STONES OF CANADA. Report. Vol. V. *Ottawa, 1917.* Purchase.

BUREAU OF RAILWAY ECONOMICS. Summary of Railway Returns year ending Dec. 31, 1917. *Washington, 1918.* Gift of Bureau of Railway Economics.

CALCUL DES SYSTÈMES ELASTIQUES DE LA CONSTRUCTION. By Ernest Flamard. *Paris, 1918.* Purchase.

CALIFORNIA Railroad Commission. Decisions. Vol. XIV, 1917. *Sacramento, 1918.* Purchase.

CATSKILL AQUEDUCT CELEBRATION. Historic and Museum Publications, 1917. Gift of Geo. F. Kunz.

CHICAGO ELEVATED RAILROAD COMPANY. Safety Rules. *n. d.* Gift of Company.

CHILEAN MINING CODE, January 1, 1889. By Charles E. M. Michels. *Santiago de Chile, 1914.* Gift of author.

THE CO-INSURANCE CLAUSE. An address delivered before the 129th meeting of the Insurance Society of New York on March 7, 1916. *New York, 1918.* Gift of Insurance Society of New York.

COMBINATION, NOT COMPETITION OF RAILROADS. By Blewett Lee. (Reprinted from Michigan Law Review, May, 1918.) Gift.

DIPLOMATIC AND CONSULAR SERVICE OF THE UNITED STATES. Corrected to Aug. 31, 1918. *Washington, 1918.* Gift.

DULUTH-SUPERIOR HARBOR. Statistical Report of Marine Commerce of Duluth, Minn., and Superior, Wis. *1917.* Gift of Alfred D. Flinn.

L'ELECROCHIMIE ET L'ELECTROMÉTALLURGIE. By Albert Levasseur. *Paris, 1917.* Purchase.

THE ELECTRICIAN. Annual tables of electricity undertakings of the United Kingdom, the Colonies and Foreign Countries. *London, 1918.* Purchase.

ELECTRICAL BLUE BOOK. The Buyers' Encyclopedia of Electrical Material. Ed. 8th, 1918. *Chicago, 1918.* Gift of Alfred D. Flinn.

ENGINEERING ASSOCIATION OF NEW SOUTH WALES. Minutes of Proceedings, Vol. XXXII. *Sydney, 1918.* Purchase.

ENGINEERING PROFESSION FIFTY YEARS HENCE. By J. A. L. Waddell. (Reprinted from *Scientific Monthly*, Vol. VI, June 1918; Vol. VII, July-Aug. 1918.) *Lancaster, 1918.* Gift of author.

FARES AND FREIGHT RATES. What of the Aftermath of Government control of railroads? By H. W. Seaman. (Bulletin No. 46, City National Bank, *Clinton, Iowa*). *1918.* Gift of City National Bank.

FOOD SUPPLY AND THE WAR, as shown by the Report of the New York State Food Supply Commission. *Albany, 1918.* Gift of New York State Food Commission.

FORMATIONS GÉOLOGIQUES AURIFÈRES DE L'AFRIQUE DU SUD. By René de Bonand. *Paris, 1917.* Purchase.

FROM THE FALLS TO THE FACTORY: a treatise on electric power transmission. British Aluminum Company. *London, n. d.*

FUEL SAVING IN POWER PLANTS. (Bulletin No. 1, Advisory Engineering Committee to the Massachusetts Fuel Administrator). *Boston, 1918.*

GRAVITY AND TEMPERATURE TABLES FOR MINERAL OILS FROM DETERMINATIONS OF THE BUREAU OF STANDARDS AND OTHER TABLES FOR GENERAL TESTING AND REFINERY PRACTICE. Compiled and edited by E. N. Hurlburt. *Rochester, 1918.* Gift of Taylor Instrument Companies.

GREAT BRITAIN. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. First Report of the Mine Rescue Apparatus Research Committee. *London, 1918.*

——— Report of the Committee of the Privy Council. 1917-18. *London, 1918.* Gift of Department of Scientific and Industrial Research.

HARTFORD PUBLIC LIBRARY. Annual Report of the Directors. 18th, 1918. *Hartford, 1918.* Gift of Public Library.

INTERNATIONAL MILITARY DIGEST. Annual, 1917. *New York, 1918.* Purchase.

AN INVESTIGATION INTO THE THERAPEUTIC VALUE OF COMPRESSED YEAST. By P. B. Hawk. (Reprinted from the *Journal of the American Medical Association.*) *New York, 1917.* Gift of The Fleischmann Company.

JANE'S FIGHTING SHIPS, 1917. An encyclopedia of the navies of the world. *London, 1917.* Purchase.

KINGDOM OF BELGIUM. Ministry of Justice and Ministry of Foreign Affairs, War of 1914-1916. Reply to the German white book of the 10th May, 1915, Die völkerrechtswidrige Führung des belgischen volkskriegs. *London, 1918.* Gift of Service Bureau of the Committee on Public Affairs.

PROCTOR KNOTT'S SPEECH ON DULUTH, issued by the Public Affairs Committee of the Commercial Club of Duluth. Gift of Alfred D. Flinn.

LA DISTILLATION FRACTIONNÉE ET LA RECTIFICATION. By Charles Mariller. *Paris, 1917.* Purchase.

LAYING THE RAILS FOR FUTURE BUSINESS, with a synopsis of the Law for the Federal Control of Railroads. *New York, 1918.* Gift of Guaranty Trust Company.

LESSONS IN COMMUNITY AND NATIONAL LIFE. Series A, for the upper classes of the high school. *Washington, 1918.* Gift of U. S. Bureau of Education.

MERCHANTS' ASSOCIATION OF NEW YORK. I. Opposing Government Ownership and Operation of Public Utilities; II. Advocating Exclusive Regulation of All Railroads by the Federal Government. Nov. 1916. Gift of Merchants' Association of New York.

METROPOLITAN WATER BOARD. 12th Annual report on the results of the chemical and bacteriological examination of the London waters for the twelve months ended 31st March, 1918. By A. C. Houston. *London, 1918.* Purchase.

MINERALS AND METALS FOR WAR PURPOSES. Hearings before the Committee on Mines and Mining, United States Senate, 65th Congress, Second Session. *Washington, 1918.* Gift.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC, 1917. *Quebec, 1918.* Purchase.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. Annual Report. 3d, 1917. *Washington, 1918.* Gift of A.S.M.E.

NEW ORLEANS, LA. Sewerage and Water Board. Report, 36th semi-annual. *New Orleans, 1917.* Gift of Sewerage and Water Board.

NEW YORK STATE. Chamber of Commerce. Annual Report of the Corporation. 60th, 1917-18. *New York, 1918.* Gift of Chamber of Commerce.

NEW YORK STATE. Public Service Commission, Second District. Annual Report. 1917—II. *Albany, 1918.* Gift of New York State Public Service Commission.

NEW YORK TIMES INDEX. April-June 1918. Volume VII. *New York, 1918.* Purchase.

OGDEN CITY, UTAH. Monthly Financial Statement, May 1918, also containing summary of proceedings of the Board of Commissioners for the month of May 1918. Gift of City Recorder.

OIL, PAINT AND DRUG REPORTER. Green book for buyers. Fall edition, 1918. *New York, 1918.* Gift of Oil, Paint & Drug Reporter.

PENNSYLVANIA. Department of Agriculture. Feeding Stuffs Report, 1917. (General bulletin No. 312). *Harrisburg, 1918.* Purchase.

POCKET LIST OF RAILROAD OFFICIALS, No. 95, 1918. *New York, 1918.* Purchase.

PORTLAND CEMENT ASSOCIATION. Magazine List, August, 1918. *Chicago, 1918.* Gift of Association.

PUBLIC UTILITIES REPORTS—ANNOTATED, 1918 (—) B. C. *Rochester, 1918.* Purchase.

RECENT REVOLUTION IN ORGAN BUILDING. By G. L. Miller. Ed. 2. *New York, 1913* Gift of Samuel Wein.

RECONNOISSANCE SOIL SURVEY OF NORTH EASTERN WISCONSIN, with maps. (Bulletin No. XLVII to L, Soil Series 12-15.) *Madison, 1916.* Purchase.

TRADE CATALOGUES

BIGELOW COMPANY. New Haven, Conn.
Catalogue describing the Bigelow Hornsby water-tube boiler. 1917.

BURT MANUFACTURING COMPANY. Akron, Ohio.
General catalogue on oil filters, exhaust heads and ventilators. 1917.
Blue print of Burt unit-type filter. 1914.

DEFENDER AUTOMATIC REGULATOR COMPANY. St. Louis, Mo.
Catalog No. 10. n. d.

E. I. DU PONT DE NEMOURS & COMPANY. Wilmington, Del.
Blasters' Handbook. 1918.

GENERAL ELECTRIC COMPANY. Schenectady, N. Y.
Bulletin No. 40017. Small Direct Current Generators, Type ML. August 1918.
——— No. 47702. Rheostat and Compensator Operating Mechanisms. August 1918.

GENERAL ELECTRIC COMPANY, IVANHOE REGENT WORKS. Cleveland, Ohio.
Catalog No. 276. Ivanhoe metal reflectors and fittings for industrial illumination. 1918.

HARRISON SAFETY BOILER WORKS. Philadelphia, Pa.
Catalog No. 550. Cochrane Steam and Oil Separators.
——— No. 710. Cochrane Heaters for Steam Power Plants.
Engineering Leaflet No. 18. Testing V-Notch Meters.
Cochrane Exhaust Steam Heating Encyclopedia. 1914.

JEFFREY MFG. CO. Columbus Ohio.
Catalog No. 175. Jeffrey Standard Belt Conveyers.

LARNER-JOHNSON VALVE AND ENGINEERING COMPANY. Philadelphia, Pa.
Bulletin No. 1. Johnson hydraulic valve. July, 1918.

NEW ENGLAND TANK AND TOWER COMPANY. Everett, Mass.
Wood tanks. (Catalogue F.)

REYNOLDS ELECTRIC COMPANY. Chicago, Ill.
Bulletin No. 22. Reco color hoods. June 15, 1915.
——— No. 27. Reco flashers. July 1, 1915.
——— No. 33. Reco flashers. Dec. 1, 1915.
——— No. 202. Type "A" alternating-current motors.

ROSS HEATER AND MANUFACTURING COMPANY. Buffalo, N. Y.
Catalogue B. Ross crosshead-guided expansion joint.

RICHARDSON SCALE COMPANY. Passaic, N. J.
Descriptive booklet describing Richardson automatic scales for pulverized coal.

SMITH-SERRELL COMPANY, INC. New York City.
Bulletin No. 26. Francke flexible couplings. 1918.

STEPHENS-ADAMSON MFG. CO. Aurora, Ill.
The Labor Saver. October 1918.

TIDE WATER OIL COMPANY. New York, N. Y.
Veedol, lubrication of internal combustion engines. Ed. 4, 1918.

UNITED FILTERS CORPORATION. Brooklyn, N. Y.
Sweetland's patent metallic filter cloth.

WHEELER CONDENSER AND ENGINEERING COMPANY. Carteret, N. J.
Bulletin 112-A. Condensers, pumps, cooling towers, etc. 1918.

WORTHINGTON PUMP AND MACHINERY CORPORATION. New York, N. Y.
Vertical triplex power pumps, single and double acting. (D-702) May, 1918.

YARNALL WARING COMPANY. Philadelphia, Pa.
Engineering devices for the power plant. Descriptive booklet.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by December 15 in order to appear in the January issue.

CHANGES OF POSITION

OTTO DA COSTA-SCHMIDT, formerly affiliated with the Treadwell Engineering Company, Easton, Pa., has entered the employ of the Ohio Bronze Powder Company, Cleveland, Ohio.

SIDNEY G. WALKER, until recently associated with the Manufacturers' Mutual Fire Insurance Company, Providence, R. I., has assumed the position of vice-president of the New York Reciprocal Underwriters, with headquarters at New York.

O. G. JENNER has resigned his position of superintendent with the Wilson and Bennett Manufacturing Company, Chicago, Ill., to assume a similar position with the Equipment Corporation of America, of the same city.

ADOLPH STARR has entered the employ of the Locomotive Superheater Company, New York, in the capacity of erecting engineer. Mr. Starr was, until recently, chief gage inspector, Winchester Repeating Arms Company, New Haven, Conn.

HARRY E. HENRICKSON, formerly connected with the S. S. White Dental Manufacturing Company, has become associated with the Remington Arms and Ammunition Company, Bridgeport Works, as a process engineer.

WILLIAM V. LOWE, formerly associated with the engineering department of John Bath Company, Fitchburg, Mass., has assumed the duties of foreman of the training school of the Putnam Machine Company, Fitchburg, Mass., which is one of the branches of the Manning, Maxwell and Moore Company. The training school, or vestibule school, has been established throughout the country to provide workmen for the shop to take the places of those who have gone to the front.

J. D. GOULETTE has accepted the position of construction engineer with the Gulf Production Company, Eastland, Tex. He was, until recently, affiliated with the Gulf Refining Company, Shreveport, La., in the capacity of construction engineer and plant superintendent.

GEORGE S. BLANKENHORN, resigned from the American International Shipbuilding Corporation, on August 1, as engineer of steam machinery, and since then has been connected with the Wilson-Snyder Pumping Machinery Company, as engineer in their Philadelphia, Pa., district.

LOUIS J. PELISSIER, formerly equipment engineer of the Norwich, Conn., Division of the Marlin Rockwell Corporation, is now mechanical superintendent of the Tacony, Philadelphia Division of the same company.

J. H. ROMANN, formerly connected with the Chicago, Ill., office of Joseph T. Ryerson and Son, is now in charge of the export division of the company in New York, which has recently been opened.

JOHN G. SHIRLEY, assistant works manager of the Gilbert and Barker Manufacturing Company, Springfield, Mass., has accepted an appointment as production manager of the S. K. F. Ball Bearing Company, Hartford, Conn.

PERCY A. MCKITTRICK, for 20 years with the Saco-Lowell Shops and the Lowell Machine Shop, has severed his connection with that company and is now assistant treasurer of the Parks-Cramer Company, of Fitchburg, Mass. The Parks-Cramer Company is a recent consolidation of two firms well known in mill circles, the G. M. Parks Company, of Fitchburg, Mass., and Stuart W. Cramer, of Charlotte, N. C.

FREDERICK A. ALDEN, formerly connected with Fay, Spoffard and Thorndike, Boston, Mass., as mechanical engineer, has assumed the duties of division engineer, Sea Service Bureau, United States Shipping Board, Boston, Mass.

LEWIS H. MILLER has become affiliated with the Babcock and Wilcox Company, Barberton, O., in the capacity of designing engineer of the plant engineering department. He was formerly associated with the Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., as mechanical engineer.

GEORGE H. JOHN, JR., until recently planning engineer with the Stokes and Smith Company, Philadelphia, Pa., has assumed the duties of instructor in mechanical engineering, Columbia University, New York.

JOHN B. PURVES, formerly associated with the Combined Locks Paper Company, Combined Locks, Wis., has resigned his position and has assumed the duties of mill manager with the Interlake Pulp and Paper Company, Appleton, Wis.

STEPHEN H. PAINTER has become special representative of the Ingersoll-Rand Company, in Chile and in Bolivia. He was formerly associated with the company in New York, as manager of the calyx drill department.

PHILIP M. HATHAWAY has resigned his position with the International Register Company, Chicago, Ill., to become chief engineer of the National Lead Company, Crooke Works, Brooklyn, N. Y.

John W. Mershon, plant engineer at Bayles Shipyard, Inc., Port Jefferson, N. Y., is now employed in the ship construction department of the American International Shipbuilding Corporation, Hog Island, Pa.

Stephen Thomas, formerly combustion engineer for the Goodyear Tire and Rubber Company at Akron, Ohio, has accepted a similar position with the E. I. du Pont de Nemours Company, Wilmington, Del.

ANNOUNCEMENTS

F. H. Rosencrants has entered the engineering department of the Electric Bond and Share Company, New York.

A. H. Pugh has accepted the position of head of the loading and explosive section, Ordnance Department, Cincinnati, Ohio.

Rupert K. Stockwell, formerly western manager, Robins Conveying Belt Company, Salt Lake City, Utah, has assumed the duties of general sales manager of the same company, with headquarters at New York.

Charles E. Waddell has assumed the office of Chief of Conservation for North Carolina, under the United States Fuel Administration.

Lieutenant William P. Hayes, United States Naval Reserve Force, is now in command of one of the United States vessels on the Asiatic Station.

Lieutenant Frank F. Boyd, U. S. N. R., since the war chief engineer of the U. S. S. *Jupiter*, a 20,000-ton electrically propelled ship, has been stationed as engineer and repair officer, Submarine Base, New London, Conn., and has been promoted to Lieutenant Commander, U. S. N. R.

Fred V. Hadley, consulting engineer for industrial furnaces, Boston, Mass., has closed his office to become associated with Tate-Jones and Company, of Pittsburgh, with headquarters at 50 Church St., New York.

Frank Mossberg has assumed the duties of vice-president and general manager of the Hooker-Mossberg Corporation, which has recently been organized in the state of Massachusetts to take over a large contract for the manufacture of airplane parts for the Government. The factory is located at Attleboro, Mass.

Frank C. Gignoux has assumed the duties of production expert, Bureau of Aircraft Production, U. S. A., Berkeley, Cal.

Charles W. Willette has accepted a position with the California Barrel Company, of San Francisco and Portland, and is engaged in drawing plans for an immense plant comprising a sawmill and barrel factory combined which, when completed, will cover about 60 acres. Mr. Willette's headquarters are in Portland, Ore.

H. Howard Heller has become associated with the Ford Instrument Company, New York, N. Y.

Julius Alsberg has entered the Division of Fats and Oils of the U. S. Food Administration with headquarters at Washington, D. C.

James C. Hobart, with the American Red Cross Ambulance Service in Italy, has been decorated by the Government for meritorious conduct in a recent offensive.

APPOINTMENTS

F. E. Matthews, specializing in mechanical refrigeration, and engaged for several months past in research work of a physico-chemical nature in connection with the commercial development of a new system of refrigeration based on chemical reaction, has accepted an appointment for the duration of the war with the United States Department of Agriculture, Bureau of Markets, with headquarters in New York. He will have to do with the study of cold storage methods and costs to the end of assisting the industry in the establishment of an equitable and uniform basis for determining operating costs of chilling, freezing and carrying various cold storage products under refrigeration.

G. P. Sonn has recently been appointed plant engineer of the National Conduit and Cable Company, Hastings, N. Y.

Henry S. Morse has been appointed chief engineer of the St. Joseph Lead Company at Herculaneum, Mo.

J. J. Swan has been appointed Lieutenant-Colonel, U. S. Army, and assigned to the Personnel Branch of the Operations Division, General Staff, Washington, D. C.

A. F. Barnes, Dean of Engineering, New Mexico College of Agriculture and Mechanic Arts, has been appointed by the United States Fuel Administration, administrative engineer for New Mexico.

H. O. C. Isenberg, formerly assistant factory manager of the Wright-Martin Aircraft Corporation, has been appointed factory manager of the corporation's New Brunswick, N. J., plant.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

Stamps should be inclosed for transmittal of applications to advertisers; non-members must accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

DIRECTOR OF WELFARE WORK and general plant coöperation with heads of departments and employees. Location, Middle West. L-0282.

DRAFTSMEN on industrial plant and power-station work. Traveling expenses and salary depending on man; $45 per week. Location, Wilmington, Delaware. L-0662.

MECHANICAL AND SAFETY ENGINEER having two or more years practical shop experience. Must be tactful and able to confer with high executives and Government officials. Excellent opportunity to make wide acquaintance in engineering profession. Salary $1800 to $2500. L-0767.

DRAFTSMAN, with experience in design of medium-weight machinery. Responsible man. Steam-engine experience valuable. Pay according to experience and ability. Location, Buffalo. L-0768.

WORKS ENGINEER, technically trained, high-class executive, to take charge of architectural and construction departments, complete power equipment, stock storage and transfer problems. Preference given to man with general manufacturing experience in addition to specializing on above problems. L-0770.

HIGH-GRADE MAN to take charge of heat-treating department, Indianapolis firm. Technically-trained man of energy, ambition and executive ability, to take hold of department and make it highly productive both in quality and quantity of work done. Some experience in carbonizing and cyaniding of steels. Fundamental grounding in heat treatment of steels and ability to trace causes through results. Should be capable executive and have genius sufficient to improve plant and equipment conditions. Position one of large opportunities. Salary $250 per month. Location, Indianapolis. L-0771.

INSTRUCTOR in practical mathematics for two or three evenings a week. Practical man preferred. L-0772.

DIRECTOR, toolmakers-apprentice school. Location, Utica, N. Y. L-0773.

MAN with aptitude for writing and engineering training and experience, training preferably in mechanical engineering to include familiarity with power-plant practice. Commercial and selling experience, and originality and interest in technical and commercial developments of advantage. Work can be so arranged that it can be done either largely at desk or combined with certain amount of traveling and interviewing of engineers and business men. Physical inability, interfering with getting about freely, would not necessarily disqualify. State training and experience and if possible send samples of own authorship. L-0774.

ASSISTANT GENERAL MANAGER, manufacturing of automobile parts in the way of transmissions, steering gears, differentials, clutches and controls for automobile trucks and tractors. At present employing 1600 men in factory with floor capacity of about 300,000 square ft. High-grade man with considerable experience in manufacturing and executive work. L-0782.

ENGINEERS AND DESIGNERS, high-grade men for permanent work. L-0784.

DESIGN AND LAYOUT MAN, not over 35, married man preferred. General knowledge of electrical construction with sufficient practical or technical training to lay out well-balanced design, together with knowledge of quantity production. Required for mechanical design of lighting, starting and ignition equipment for internal-combustion engines. Salary up to $175 per month. Location, Indiana. L-0786.

DRAFTSMAN for plant in Jones Point, N. Y. Salary $25 per week with transportation and meals. Prefer experience in chemical or sugar line. Application in hand writing. L-0787.

SALES ENGINEER, to assist with portion of engineering correspondence and problems, requiring man of technical education or training, with view to recommending and selecting proper sizes of ball bearings for various applications to fill requirements of clients. Location, Connecticut. L-0788.

MECHANICAL DRAFTSMEN, two or three for Government work. L-0797.

ENGINEER, competent to take charge of gas-engine plant, consisting of three Smith producers, two Allis-Chalmers engines, direct connected to two Bullock generators of 200-kw. each. Location, New York. L-0803.

TECHNICAL MEN in connection with experimental-engineering department, to determine by time-study method output of each operation; also study of speeds and feeds, to enable rate department to set piece rates. L-0805.

SAFETY ENGINEER, preferably with technical training, to carry on inspection service, education and committee work connected with large corporation. Location, Utica, N. Y. L-0806.

DRAFTSMAN on design-conveying machinery. Location, New York. Salary depends on man. L-0810.

MECHANICAL ENGINEER for engineering division in St. Louis Ordnance District, with considerable experience in machine design and shop practice. Capable of writing comprehensive letters concerning manufacture of ordnance material. Salary about $3000 a year. Desirable that man be familiar with manufacturing conditions of section. L-0813.

ASSISTANT INSTRUCTOR in Lowell Textile School, mechanical drawing, engineering department. Prefer man with some teaching experience. Could use one good draftsman. Salary $25 per week. L-0814.

SALES ENGINEER, age 28 to 35; keen, aggressive, tactful, pleasing personality. One who will not lose sight of engineering principles in desire for trade, willing to build from foundation up. Engineer with selling experience or salesman with engineering knowledge. Knowledge of ball-bearing field desirable. Location, Chicago. Salary $3000 to $4000. L-0815.

CHIEF INSPECTOR, age 35 to 40, electrical and mechanical; resourceful and systematic with organizing and executive ability. Thorough training with considerable practical experience in manufacturing small electrical devices. Knowledge insulating materials and very intricate processes incident to building wire-wound insulated apparatus. Good practical knowledge machine-shop practice, operation, testing and inspection. Location, Indiana. State salary. L-0816.

SHOP MANAGER AND DESIGNER on machine tools, especially engine lathes. State experience in detail during past ten years, capacity for producing results and salary expected. Location, Cincinnati. L-0818.

TWO INSTRUCTORS in mechanical drawing and descriptive geometry. Location, Hoboken, N. J. L-0819.

CHIEF ENGINEER, technical graduate, preferably mechanical; over 30 years of age, with good experience. Wanted for concern making pipe and pipe-bending machinery. Location, Harrisburg, Pa. L-0820.

FIELD INSTRUCTOR in mechanical-engineering extension division University of Wisconsin. Location probably at Milwaukee. L-0821.

YOUNG ENGINEER, at least five years' experience since graduation with operation and maintenance of mechanical equipment; an assistant master mechanic. Salary $250 per month. L-0822.

DESIGNER AND DRAFTSMAN, 30 to 40 years old. Single men preferred. Position permanent; designing ability in gas-engine electrical work of from ½ to 5 kw. capacity. Production is small gas-engine electric-direct electric-connected unit. Salary $2400 and up. Headquarters at Dayton, Ohio. L-0823.

GAS ENGINEER, one capable of testing meters, calculating flow of gas, handling all mechanical details connected with gathering and distributing natural gas. Location, Oklahoma. L-0825.

ASSISTANT for material inspection needed. Man versed in actual inspection and tests of boiler tubes, boiler plate, ship plate and structural steel for ships. Essential that applicant be conscientious and absolutely trustworthy. Accuracy in mathematics required and references desired. Salary $175 per month, together with arrangement regarding traveling expenses. L-0827.

MECHANICAL DRAFTSMAN for essential work around furnaces and mines. State age, experience, reference and salary expected. L-0828.

ASSISTANT PURCHASING AGENT familiar with electrical equipment. Must be familiar with purchasing methods to obtain definite promises of delivery, and able to follow these up and see that promises are kept. Salary about $200 per month to start. Location, Middle West. L-0829.

FIRST-CLASS PRODUCTION MANAGER. Capable of supervising clerical record, thoroughly familiar with brass and aluminum foundry methods and machine shop and assembling practice. Department is in charge of handling all orders through factory and keeping machinery and other facilities properly employed, maintaining shipping dates and stock requirements with greatest possible degree of accuracy. Salary $4000 to $4500 per year. Location, Detroit. L-0831.

FACTORY-PLANT ENGINEERS. General manager and assistant general manager for manufacturing paper. Age 25 to 40. Salary $300 per month. Headquarters, Paterson, N. J. L-0832.

ASSISTANT TO ENGINEER in charge of construction work; Government proposition in Southern Jersey. Man familiar with C. E. fundamentals and office work in connection with varied construction. Salary $275. L-0833.

CHEMIST AND METALLURGIST. Foundry work. Salary depends on applicant's ability. Location Middle West. L-0836.

MAINTENANCE ENGINEER. Familiar with machine-shop practice, maintenance, and mechanical engineering. Shop work. Salary depends on applicant's ability. Location Middle West. L-0837.

MECHANICAL ENGINEER, experienced in design of high-grade steam engines and boilers, especially of the marine type. Thoroughly experienced man with good record required, and one able to handle draftsmen. Give age and experience in detail and salary desired. Location, Pa. L-0838.

CHIEF ENGINEER, familiar with design of structural and plate work, hoisting and conveying machinery of the heaviest type. Must have executive ability of highest order. Give age and experience in detail and salary desired. Location, Pa. L-0839.

WORKS MANAGER for plant located in middle west, manufacturing high-grade medium and heavy metal-working machinery. Must be at present similarly employed and have had extensive machine-tool experience, be a good organizer with years of experience in handling men; must be from plant with not less than 600 men under his direction. L-0845.

MEN AVAILABLE

Only members of the Society are listed in the published notices of this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER. Age 31, 11 years' experience on maintenance and installation of mechanical and electrical equipment of machine shops, automobile factories, and cotton mills. At present plant engineer of large machine shop employing 3000. Salary $3000. L-283.

SUPERINTENDENT OR CHIEF ENGINEER of power plants or superintendent of plant and factory construction. Specially trained in handling large work in best engineering practice. Ten years' practical experience since graduation from technical school. American, age 33 years, ready to go anywhere. Now employed but can obtain release when necessary. Design, construction, operation, and maintenance of plants a specialty. L-284.

MECHANICAL ENGINEER, technical graduate and associate member, desires position as manager where executive ability is necessary with an extensive knowledge of modern scientific and production management. Held positions of superintendent and factory manager and with consulting industrial engineers. Will consider proposition only where high-grade man is required. Available about January 1. L-285.

MANAGER OR SUPERINTENDENT. Technical graduate; 20 years' experience in the manufacture of machine tools, gasoline engines, and electrical machinery in positions from machinist to manager. Also experienced in equipment of buildings and in use of modern methods in plant management and production engineering. At present superintendent. L-286.

PRODUCTION, EFFICIENCY ENGINEER, 15 years' technical and practical experience covering all branches of manufacturing. Have pleasing personality; six years as executive. At present with one of the largest automotive companies. Desire association with financial business man or promotor requiring man of ability to organize new business or give new life to an old one. Any correspondence must be confidential and proposition high-grade and essential. L-287.

MECHANICAL ENGINEER, age 30, eight years' broad experience. Last four years as chief draftsman on design, construction and maintenance in power plant of large public service company, and still so employed. Desires engineering position with large manufacturing or public utility company. L-288.

PRODUCTION OR PRODUCTION EQUIPMENT ENGINEER, or other responsible position, designing or manufacturing end or both. Salary about $4000. Would like to correspond with party needing self-starting man. Practical mechanic and designer. Experience covers originating, designing, building and operating numerous special and standard automatic and semi-automatic machines for producing wide variety of articles from wire, sheet metals, paper, wood, etc., for assembling, labor saving, processing, conveying, cost reducing, etc.: punches and dies, jigs, fixtures and tools and general engineering routine, cost accounting, bookkeeping, time study and production. Twenty-eight years old, married, with family. Will go anywhere. L-289.

EXECUTIVE, graduate naval architect and mechanical engineer. Member, ten years' broad practical experience in shipbuilding, steel-plate construction, oil engines and special machinery, filling positions of chief draftsman, engineer, works manager and general manager. Available January 1. Salary $5000; familiar with modern accounting, cost keeping, production and manufacturing methods and all phases of plant equipment, maintenance and operation. L-290.

MANAGER, GENERAL SUPERINTENDENT OR SUPERINTENDENT. Industrial engineer, member, American, age 42. Twenty-one years' broad experience covering design, manufacture, construction and operation, appraisal and investigation, cost analysis, purchasing and management, special machinery in manufacturing machine shops, covering engines, boilers, overfeed and underfeed stokers; kilns, dryers and metallurgical furnaces, pumps, condensers, evaporators and distillers; mining, conveying, transmission and process machinery; machine shop, power, water works, cotton-seed oil, cement, hydrated lime and chemical plant design; operation construction and direction during past ten years; at present on large Government plant construction. Seeks responsible permanent connection. Salary minimum $6000 per year to start. L-291.

MECHANICAL ENGINEER with eight years' experience in design and manufacturing. One year experimental and research engineering on rifles and machine guns and small interchangeable parts. Technical graduate. L-292.

SUPERINTENDENT, WORKS MANAGER, PRODUCTION SUPERINTENDENT, shell-forging plants, shipyards, machine or structural shops. Salary $4000 to $5000. Location preferably in the East. L-293.

SALES MANAGER OR SALES ENGINEER. American, 13 years' experience covering designing, construction, manufacturing and selling. Have initiative and ability to get results. At present employed as sales engineer; five years with large manufacturer; desires change about January 1, 1919. L-294.

EXECUTIVE, SALES ENGINEER, highly successful, desires change. Available January 1, 1919. Fifteen years' experience in Eastern territory dealing with executives, managers and consulting engineers almost entirely, and selling with the largest concerns in the country. Graduate mechanical engineer, good correspondent, well connected. Salary and commission preferred. Willing to make a moderate start with the right concern. L-295.

MECHANICAL ENGINEER, associate member, age 36, experienced in design, manufacture, sale and installation of rubber and wire machinery. Can show a successful record for 20 years, last five years as chief engineer of small plant manufacturing above lines. Desires position as chief engineer or chief draftsman of larger plant or as chief engineer of rubber or wire factory. Location East or Middle West. Available on 30 days' notice. Salary $4000. L-296.

WORKS ENGINEER. Graduate mechanical engineer. Thirty-three years old. Three years' shop experience, six years with leading steel-car manufacturing company; three years steel works. Active and energetic. Now employed. Will go anywhere. L-297.

INDUSTRIAL ENGINEER, three and a half years' experience installing scientific management methods. At present connected with prominent engineering concern doing this type of work. Desires position which involves little or no traveling. Age 27, married; available January 1. L-298.

POWER-PLANT ENGINEER, technical graduate, age 32, married; eight years' experience in steam-power plants, recently employed as superintendent of power. At present engaged in war work. Wish permanent position in power-plant operation, design of construction. L-299.

MECHANICAL ENGINEER, American, 23, four years apprentice as machinist in smelter, will graduate from Rensselaer in January. L-300.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER DECEMBER 21

BELOW is a list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. The total number of applications listed below is 153.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by December 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

MACGUIRE, JAMES, Chief Inspector, Power Plant Equipment, Air Nitrates Corporation, Muscle Shoals
MIDDLEMISS, GEORGE H., Superintendent, Maintenance and Repairs, Alabama Power Company, Birmingham
PERRY, HARRY M., Southern District Manager, Ingersoll Rand Co., Birmingham

California

HELLERMAN, GEORGE N., Chief Engineer, San Diego Electric R. R., San Diego
KING, PETER M., Mechanical Engineer, General Petroleum Corporation, Vernon
MARDEL, CHARLES M., Chief Engineer, Oakland Antioch & Eastern R. R., Oakland
WILSON, WILLIAM W., Vice-President, Treasurer and Manager, Wilson & Willard Manufacturing Company, Los Angeles

Colorado

WOOLFENDEN, HENRY L., District Manager, Allis-Chalmers Manufacturing Company, Denver

Connecticut

BREITENSTEIN, ALBERT F., Designing Engineer and Chief Draftsman, The Geometric Tool Company, New Haven
BRISTOW, WILLIAM, Mechanical Engineer, Ordnance Department, U. S. A., Remington Arms, Bridgeport
BURNS, ROBERT H., Engineer, Remington Arms Company, Bridgeport
HALLOCK, HENRY E., Equipment Engineer, Marlin-Rockwell Corporation, New Haven
SMITH, PETER L., Superintendent, Power Department, Winchester Repeating Arms Company, New Haven
VAN SCHAACK, DAVID, Director, Aetna Life Insurance Company, Hartford
WOOD, BURTON S., Teacher of Manual Training, Driggs School, Waterbury

Delaware

SWAYZE, WILLIAM W., Mechanical Engineer, Wilmington

District of Columbia

HORWITZ, SAMUEL S., Captain of Engineers, U. S. A., Washington

Illinois

BUHMEYER, CLAUDE H., Assistant Production Manager, Free Sewing Machine Company, Rockford
CURRIER, CHARLES H., Vice-President, Drying Systems, Inc., Chicago
McBRIDE, HERBERT K., Structural & Mechanical Engineer, Wilson & Company, Chicago
PRITCHARD, RALPH W., Engineer Assistant to Manager, The Pullman Company, Pullman
SHAW, ENOS L., Civil Engineer, Chicago
SHUMATE, FRANK D., Mechanical Sales Engineer, Worthington Pump & Machinery Corporation, Chicago
WILSON, ALEXANDER H., Assistant Chief Draftsman, Amalgamated Machinery Corporation, Chicago

Indiana

CRAWFORD, CHARLES S., Assistant General Manager and Chief Engineer, Premier Motor Corporation, Indianapolis
SIMS, ERNEST M., Secretary, Treasurer and Factory Manager, Metal Forming Corporation, Elkhart

Iowa

STODDART, FRANK P., Chief Mechanical Engineer, Murray Iron Works Company, Burlington

Maryland

BATHURST, ARTHUR F., Mechanical Superintendent, Crown Cork & Seal Company, Cartridge Manufacturing Division, Baltimore
HERITAGE, ARTHUR M., Engineer, U. S. Army, Edgewood

Massachusetts

AUDET, HERBERT R., Captain, U. S. Government Arsenal, Springfield Armory, Springfield
BRISTOL, BENNET B., Treasurer, The Foxboro Company, Foxboro
BUDLONG, GUY V., Power Engineer, American Steel & Wire Company, Worcester
HALL, WALTER B., Agent, Thorndike Company, Warren Cotton Mills, West Warren
HOOK, HENRY C., General Foreman, Norton Grinding Co., Worcester
KEOUGH, PETER F., General Mechanical Superintendent, Springdale Finishing Company, Canton
MANN, WILLIAM D., Chief Engineer, American Incandescent Heat Company, Roxton
MITCHELL, JOHN H., Plant Engineer, Hamilton Woolen Company, Southbridge
ROCHE, WESLEY C., 1st Lieutenant, Ordnance Department, Watertown Arsenal Production, Watertown

Michigan

HILL, WILLIAM C., Plants Engineer, Northwestern Leather Company, Sault Ste Marie
TAYLER, THERON C., Assistant Mechanical Engineer, Ford Motor Company, Detroit
TURNBULL, JOHN G., Mechanical and Electrical Engineer, Albert Kahn & Associates, Detroit

New Hampshire

FARMER, NOYES D., Supervisor of Costs, Atlantic Corporation, Portsmouth
HARMON, HARRY T., Master Mechanic, The Atlantic Corporation, Portsmouth

New Jersey

BELLER, IGNATIUS, Designing Engineer, Balbach Smelting & Refining Company, Newark
SPILLMAN, MAX, Works Engineer, Henry R. Worthington, Harrison
WHITNEY, OSCAR C., Engineer, Pintsch Compressing Company, Jersey City

New York

BAILEY, RAYMOND C., Expert Aid, Electrical and Mechanical, Public Works Department, New York Navy, New York
DICKINSON, JOSEPH H., Engineer and Manager, Logging Machinery Department, Lidgerwood Manufacturing Company, New York
HOFFMAN, WILLIAM H., Mechanical Engineer, Ford, Bacon & Davis, New York
LOGAN, WILLIAM, SR., Superintendent, James Stewart & Company, New York
McLEAN, EMBURY, Treasurer and Chief Engineer, The Engineer Company, New York
PFARRE, EDGAR G., Chief Engineer, George Tiemann & Company, New York
SEXTON, FRANK B., Manager of Sales, Van Blerck Motor Company, New York
SPRAGUE, LUCION C., Assistant Secretary and District Manager, Chicago Pneumatic Tool Corporation, New York
STORER, HARRY D., District Manager, New York City, Kerr Turbine Company, Wellsville
WAGNER, JULIUS H., Proprietor, Sheet Metal Contracting Business, Brooklyn
WEARIN, FRANK W., Engineer, Selson Engineering Company, New York
WILSON, JAMES A., Lieutenant, Naval Overseas Transportation Service, U. S. A., New York

Ohio

CAIN, JOHN N., Locomotive Engineer, Ashtabula
FISHBOUGH, HARRY E., Mechanical Engineer, The Hoppers Manufacturing Company, Springfield
MARSH, EDWARD L., Vice-President and Treasurer, The Bay View Foundry Company, Sandusky
SPROULL, JOHN C., Balloon Engineer, The B. F. Goodrich Company, Akron

Pennsylvania

BINZ, GUSTAV A., Sales Manager, Yarnall-Daring Company, Philadelphia
BRAEMER, WM. G. R., Consulting, Air Conditioning and Industrial Engineer, Philadelphia
KING, ALVIN W., Sales Manager, Nelson Valve Company, Philadelphia
RUSHTON, KENNETH, Chief Mechanical Engineer, The Baldwin Locomotive Works, Philadelphia
UZELMEIER, WILLIAM, Assistant Chief of Engineering Department, Harrison Safety Boiler Works, Philadelphia
WAGNER, CLYDE A., Construction Engineer, The Barrett Company, Philadelphia
WEBSTER, HOWARD J., Consulting Engineer, President, Uniflow Boiler Company, Philadelphia

Rhode Island

BIGELOW, FRED C. JR., Mechanical Superintendent, River Spinning Company, Philipsdale
STAHL, NICHOLAS, General Engineer, Narragansett Electric Lighting Company, Providence

Texas

PRATT, CLARENCE E., Consulting Engineer, Seymour

Wisconsin

CAHILL, CHARLES A., Administrative Engineer, Wisconsin Federal Fuel Administration, Milwaukee

Canada

FROST, EDGAR R., Mechanical Superintendent, Metals Chemical, Ltd., Welland, Ontario
McROBERT, WILLIAM M., Manager, Galt Foundry Company, Ltd., Galt, Ontario
ROBERTS, THOMAS L., Consulting Mechanical and Marine Engineer, Winnipeg

Cuba

CAMP, LEE G., Chief Engineer, Cuba Cane Sugar Corporation, Habana

Federated Malay States

SCOTT, JOHN MURRAY, Engineer, Nova Scotia Estate, Perak

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California

O'NEILL, PAUL A., Superintendent, Union Machine Company, San Francisco

Illinois

HOFSTETTER, ROBERT, Mechanical Engineer, Illinois Tool Works, Chicago

New York

BURNS, RAYMOND W., Estimator, Watervliet Arsenal, Watervliet

Ohio

KLEMIN, ALEXANDER, 2nd Lieutenant, in charge Aeronautic Research Section, A. E. D. McCook Field, Dayton

RYDER, JAMES C., Aeronautical Mechanical Engineer, Bureau of Aircraft & Production, Dayton

Pennsylvania

REIBER, HARRY P., Mechanical Engineer, Oil Well Supply Company, Pittsburgh

Texas

SCHMAUDER, WALTER G., Superintendent of Power, Texas Power & Light Company, Dallas

Wisconsin

SHUTE, ROBERT L., Works Engineer, The Albert Trostel & Sons Company, Milwaukee

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Illinois

DIBBLE, CLAUDE M., Erecting Engineer, Shell Division, Pullman Company, Pullman

WALTERS, RUSSELL J., Tool Designer, Ordnance Department, Rock Island Arsenal, Rock Island

Maryland

KERR, GEORGE M., 1st Lieutenant, C. W. S., U. S. Army, Edgewood Arsenal, Edgewood

Massachusetts

HOWARD, STANLEY R., 1st Lieutenant, Ordnance Department, U. S. A. Watertown Arsenal, Watertown

Michigan

CHATFIELD, VICTOR M., Chief Engineer, Bostaph Engineering Corporation, Detroit

New Jersey

BAKER, EDWARD, Superintendent Webb Wire Works, New Brunswick

GESELL, WILLIAM H., General Manager, Hamersley Manufacturing Co., Garfield

OLSON, OSCAR W., Leading Draftsman, Stationary Drafting Department, Babcock & Wilcox Company, Bayonne

New York

MILLER, RALPH, Erecting and Service Engineer, De La Vergne Machine Company, New York

PAGE, GEORGE A., Chief in Charge of Patent Department, also Auxiliary Engineer Mechanical Division, Bausch & Lomb Optical Company, Rochester

TITTERINGTON, MORRIS M., Chief Engineer, Aircraft Section, Sperry Gyroscope Company, Brooklyn

Ohio

DAY, ALFRED C., Captain, Chemical Warfare Service, U. S. A., Chillicothe

McHUGH, EDWIN C., Consulting Engineer, Cincinnati

VERKAMP, WALTER F., Secretary and Engineer, The Ohio Electrolytic Oxygen Company, Cincinnati

Pennsylvania

CUSHMAN, PAUL A., Assistant Professor of Mechanical Engineering, Penn State College, State College

PETTY, JOHN, President and General Manager, Lebanon Boiler Works, Lebanon

Wisconsin

BERKELEY, LAWRENCE J., Vice-President and Chief Engineer, Hercules Manufacturing Company, Racine

France

GOSS, LEONARD K., 1st Lieutenant, Ordnance, U. S. A., American Expeditionary Forces

VAN WYCK, PHILIP S., 2nd Lieutenant, c/o Co. A, 67th Engineers, American Expeditionary Forces

FOR CONSIDERATION AS JUNIOR

Connecticut

ATHERTON, RUSSELL, Chief Machinist Mate, U. S. Naval Experimental Station, New London

DUPONT, ANDREW T., Machinery Scientific Section, Lake Torpedo Boat Co., Bridgeport

RICE, KENNETH A., Ensign, U. S. N. R. F., Naval District Base, New London

Delaware

ANDERSON, WALTER C., Engineer, The Continental Fibre Company, Newark

SMITH, MALCOLM H., Designer, E. I. DuPont de Nemours & Company, Wilmington

District of Columbia

FARDELMANN, JOHN H. JR., Mechanical Draftsman, Engineering Bureau, War Department, Washington

MATHER, THOMAS H., Ship Draftsman, Bureau of Construction & Repair, Washington

OLIPHANT, ABNER C., Assistant Head, Gauge Branch, Inspection Division, Ordnance Department, U. S. A., Washington

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Massachusetts

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BURRILL, HAROLD G., Chief Engineer, Utica Gas & Electric Company, Utica

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Ohio

BROWN, ROBERT H., Engineer in charge of materials testing, Airplane Engineering Department, U. S. A., McCook Field, Dayton

Pennsylvania

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Wisconsin

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Porto Rico

FIOL, IGNACIO, Assistant Engineer, Fortuna Sugar Factory, Fortuna

CHANGE OF GRADING
PROMOTION FROM ASSOCIATE

Connecticut

MERKT, G. A., Chief Engineer, The American Tube & Stamping Company, Bridgeport

PROMOTION FROM ASSOCIATE-MEMBER

Connecticut

CARTER, OSCAR S., Mechanical Engineer, Connecticut Light & Power Company, Waterbury

Illinois

DANIELS, GEORGE C., Mechanical Engineer, Central Illinois Light Company, Peoria

New York

MILLETT, KENNETH B., Assistant General Engineer, American Thread Company, New York

Pennsylvania

BACHMAN, B. B., The Autocar Company, Ardmore

PROMOTION FROM JUNIOR

California

GARRETT, JOHN A., Mechanical Engineer, Fairbanks Morse & Company (Reinstatement), Los Angeles

Connecticut

ELIN, MICHAEL B., Engineer, Colt's Patent Fire Arms Manufacturing Company, Meriden

District of Columbia

SCHLINK, FREDERICK J., Associate Physicist, Bureau of Standards, Washington

Illinois

GATELY, WILLIAM A., 1st Lieutenant, Ordnance Department, U. S. A., Rock Island Arsenal, Rock Island

PARSONS, HARRY N., Sales Engineer, U. S. Ball Bearing Manufacturing Company, Chicago

New York

ESTABROOK, MANSFIELD, Captain, Ordnance Department, U. S. A. Inspector of Ordnance, Remington Arms Union Metallic Cartridge Company, Ilion

JONES, RUSSELL C., Vice-President, The Griscom-Russell Company, New York

KENT, ROBERT T., Supervising Engineer, Meyer, Morrison & Company, Inc., New York

Ohio

JEHLE, FERDINAND, Service Engineer, The Aluminum Castings Company, Cleveland

Rhode Island

FISHER, HOWARD C., Manager, Engineering Department, Frank A. Sayles, Pawtucket

Virginia

HENLEY, ERL K., Lieutenant, U. S. N. R. F., U. S. S. Jupiter, Norfolk

SUMMARY

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SELECTED TITLES OF ENGINEERING ARTICLES

THE section Selected Titles of Engineering Articles comprises an index to current articles on mechanical engineering and related subjects.

This work has been made possible by the remarkable collection of current technical periodicals available in the Library of the United Engineering Society, which is one of the greatest and most complete collections in the world. The Library receives, even now, when some of the foreign periodicals have ceased to come to its shelves, close to a thousand different papers, magazines and transactions of societies in the engineering and scientific fields, in not less than ten languages. The Society's engineering staff examines these publications as they are received from day to day and prepares the descriptive items which are ultimately used in the Selected Titles section of THE JOURNAL.

Chief attention is paid to articles directly concerned with the branches of mechanical engineering. When it is thought they will be of interest or value to mechanical engineers, however, other articles are listed, in the realms of physics and chemistry; civil, mining and electrical engineering, technology, etc.; and in subjects in broadly related fields such as training and education, safety engineering, fire protection, employment of labor, welfare work, housing, cost keeping, patent law, public relations, etc. Cross-references are introduced and where the titles themselves are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of page 1096.

PHOTOSTATIC PRINTS

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ACCOUNTING

Highways

Classification of Expenditures for Highway Cost Accounting. Good Roads, vol. 16, no. 19, Nov. 9, 1918, pp. 178-180. Outline of system proposed in recent publication of Office of Public Roads and Rural Engineering.

Handling Materials

Coke Loading Tipples in the Municipal Gas Works at Düsseldorf (Die Koksverladebrücke des Stadtischen Gaswerkes Düsseldorf). Journal für Gasbeleuchtung, year 61, no. 10, Mar. 9, 1918, p. 117, 1 fig.

AERONAUTICS

Aerostatics

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, p. 169, 1 fig. Observation balloon in Navy. (Continuation of serial.)

Altitude Flight

The Flight of an Aeroplane at Different Altitudes, Louis de Bazillac. Translated from original French by B. Bruce-Walker Flight, vol. 10, no. 30, July 25, 1918, pp. 836-837, 4 figs. The logarithmic diagram-formulae for resistance and total lift for unit speed. (Concluded.)

Atlantic Flight

Atlantic Flight, M. A. S. Riach. Times Eng. Supp., no. 528, Oct. 1918, p. 216. Analysis of possibility of constructing an aeroplane capable of making journey in single flight.

British Aeroplanes

The Sopwith Camel. Flight, vol. 10, no. 37, Sept. 12, 1918, pp. 1019-1022, 14 figs. Description of machine (F. I. B. 6290) built by Sopwith Aviation Co. Translated from German paper. Also in Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 361-362, 6 figs.)

Engineers, Aeronautical

The Education of Aeronautical Engineers. Aeronautics, vol. 15, no. 250, July 31, 1918, p. 96. Account of work being done in France.

Engines

The 180-hp. Mercedes Aircraft Engine. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, pp. 453-456, 9 figs. Fuel test results and table of data of development of 160-hp. model, having same cylinder dimensions, compression increased and details redesigned.

The Design of Airplane Engines (VI), John Wallace. Aeronautics, vol. 15, nos. 253, 254, 256, 257, 258, 259, Aug. 21, 28, Sept. 11, 18, 25, Oct. 2, 1918, pp. 163-164, 4 figs, 200-202, 1 fig., 236-238, 5 figs., 267-269, 7 figs., 295-297, 9 figs., 317-320, 15 figs. Aug. 21: Torque reaction; side-thrust upon cylinder walls; Désaxé cylinder; Aug. 28; weight/power ratio; weight/cylinder capacity ratio; rotary motor; power/cylinder capacity ratio; weight/power ratio; mean effective pressure; Sept. 11: Volumetric efficiency; pumping losses; gas velocity; speed of revolution, effects of increased inertia forces; piston speed; speed of propeller shaft; cylinder dimensions; stroke to bore ratio; Sept. 18: Cylinder design; objections to cast cylinders; example of side-valve cylinder; overhead valve cylinder construction; valve ports; valve guides; Sept. 25: Construction and mounting of cylinders; water jackets; colonnette bolts; strength of cylinders; 160-hp. Benz cylinder; Mono Gnome cylinder; detachable cylinder heads; Oct. 2: Poppet valves; materials for valves; proportions of valves; operation of slide valves; valve springs; operation of overhead valves; Beardmore gear; camshafts; openings and timing valves.

The 300-hp. Maybach Engine. Flight, vol. 10, nos. 35, 37, 38, Aug. 29, Sept. 12, Sept. 19, 1918, pp. 962-965, 10 figs., 1031-1035, 12 figs., 1059-1063, 12 figs. Aug. 29: General features; details of cylinder, pistons, gudgeon pins, and floating small-end bushes. Issued by Tech. Dept., Aircraft Production, Ministry of Munitions: Sept. 12, Propeller hub; lubrication, crankcase ventilation; constructional details of oil pumps; Sept. 19, carburetors; resistance test; atomization test; petrol pump; delivery tests; starting gear. Issued by Tech. Dept. Aircraft Production Ministry of Munitions. Also published in Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 216-223, 15 figs.; Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 194-196; 9 figs.; Aviation, vol. 5, nos. 6 and 7, Oct. 15, 1918, pp. 357-360, 10 figs., and Nov. 1, 1918, pp. 429-433, 13 figs.

French Aeroplanes

The French A. R. Biplane with 190-hp. Renault Motor. Flight, vol. 10, no. 38, Sept. 19, 1918, pp. 1053-1057, 12 figs. Description of machine (translated from German paper). Also in Aviation, vol. 5, no. 7, Nov. 1, 1918, pp. 423-424, 7 figs.

German Aeroplanes

German Airplane Albatros D. V. (Avion allemand Albatros D. V.) L'Aérophile, year 26, nos. 13, 14, July 1-15, 1918, p. 203, 3 figs. Scheme and dimensions.

New German Airplanes (Nouveaux avions allemands), L'Aérophile, year 26, nos. 13, 14, July 1-15, 1918, pp. 199-201, 6 figs. General characteristics of Pfalz D III, Fokker D VII, Halberstadt CII, and Riesenflugzeuge.

Report on the A. E. G. Armored Aeroplane, J. G. Weir. Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 212-214, 12 figs. Issued by Tech. Department, Aircraft Production, Ministry of Munitions. Also in Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 206-207, 11 figs.; Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 367-368, 3 figs.; Flight, vol. 10, no. 35, Aug. 29, 1918, pp. 969-972, 15 figs.

Report on the Hannoveraner Biplane. Aeronautics, vol. 15, no. 256, Sept. 11, 1918, pp. 239-245, 24 figs. Particulars of enemy machine. By Technical Department, Aircraft Production, Ministry of Munitions.

Report on Two-Seater Rumpler Biplane, G.117. Aeronautics, vol. 15, no. 256, Sept. 11, 1918, pp. 245-249, 22 figs. Details of enemy machine using 260-hp. Mercedes engine. By Technical Department, Aircraft Production, Ministry of Munitions. Also in Flight, vol. 10, no. 37, Sept. 12, 1918, pp. 1025-1030, 25 figs.

Some Fokker "Milestones." Flight, vol. 10, no. 35, Aug. 29, 1918, pp. 966-967, 8 figs. Development of Fokker firm since outbreak of war.

The German Airplane, Pfalz D. III. (L'avion allemand Pfalz D. III.) L'Aérophile, year 26, nos. 13, 14, July 1-15, 1918, pp. 193-198, 6 figs. Details of planes, tail, fuselage, motor and armament.

The Pfalz Single-Seater Fighter (II). Automotive Ind., vol. 39, nos. 11 and 12, Sept. 12 and 19, 1918, pp. 462-463, 3 figs., and 503-505, 6 figs. Mounting of tail plane, tail skid, vertical fin and rudder and construction of these parts. Sept. 19: Seating arrangement—aileron, elevator, rudder controls; landing gear. (From Flight.) Also in Engineer, vol. 126, no. 3274, Sept. 27, 1918, pp. 270-272, 16 figs.

The Zeppelin Giant Airplane. Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 365-367, 6 figs. Wire-bracing; ailerons; vertical fins and rudders; internal arrangements; armament; undercarriage, controls; weight items. (Concluded.)

Model Aeroplanes

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, p. 181, 10 figs. Construction of a 20-ft. glider. (Continuation of serial.)

Model Aeroplanes (XV), F. J. Camm. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, p. 176, 1 fig. Rudiments of aerofoil theories. (To be continued.)

Performance, Aeroplane

Airplane Performance Determined by Engine Performance, G. B. Upton. Jl. Soc. Automotive Engrs., vol. 3, no. 4, Oct. 1918, pp. 275-279, 3 figs. Curves showing altitude against engine speed for various efficiencies and speed ratios, also curves showing engine and propeller power at different altitudes and ceiling height for conventional and theoretical constant-power engine.

Propellers

Air Propeller Performance and Design by the Specific Speed Method, M. C. Stuart. Practical Engr., vol. 58, no. 1648, Sept. 26, 1918, pp. 148-150, 3 figs. Rotational speed and diameter of propeller being expressed in terms of power and forward velocity, a direct method of treatment obtained. (To be continued.)

Research

British Advisory Committee Report for 1917-1918. Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 368-370. Account of experimental work at National Physical Laboratory in aerodynamics and strength of construction.

The National Physical Laboratory Report, 1917-1918. Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 226-227. References to aeronautical work.

Third Annual Report of the National Advisory Committee on Aeronautics. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, pp. 174-175. Board of war inventions in aeronautics; metric system for drawings and calculations; technical reports; general problems and activities. (Continuation of serial.) Also in Aeronautics, vol. 15, no. 256, Sept. 11, 1918, pp. 250-253.

Stresses in Structure

Stresses in Airplane Ribs, Irving H. Cowdrey. Aviation, vol. 5, no. 7, Nov. 1, 1918, pp. 425-428, 5 figs. Transverse testing under non-uniformly distributed load with special application to airplane wing ribs. Before Am. Soc. for Testing Materials.

The Stresses in a Fuselage in Torsion, H. A. Webb. Aeronautics, vol. 15, no. 250, July 31, 1918, pp. 105-106, 4 figs. Method of approximation based on assumption that wires are initially unstretched and torsion is carried entirely by wires, the struts and longerons merely holding them in position.

Trajectory, Aeroplane

Trajectory of Airplane Equipped with a Fuselage. (Trajectoire de l'aéroplane à nacelle), L. Farand, L'Aérophile, year 26, nos. 13 and 14, July 1-15, 1918, pp. 204-208, 12 figs. Mathematical computation of hodograph based on assumption that the angle of the planes with the trajectory remains constant and that the force of propulsion remains always horizontal.

See also Engineering Materials (Aeroplane Fabrics); Internal-Combustion Engineering; Standards and Standardization (Aircraft Materials); Wood (Aeroplane Woods).

AIR MACHINERY

Air Supply to Boiler Room

The Air Supply to Boiler Rooms, Richard W.

Allen. Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 198-199, 10 figs. Considering chiefly air supply to closed stokeholds. Paper before Instn. of Naval Architects, March 1918.

Blowers

Blower for Water-Tube Boiler Plant at Bristol Electricity Works. Engineering, vol. 106, no. 2744, Aug. 2, 1918, pp. 126, 13 figs. Drawings of boiler and blower arrangements.

Compressed Air

The Use of Compressed Air (l'emploi de l'air comprimé), M. C. F. Bernard. L'Echo des Mines, no. 2594, Oct. 6, 1918, pp. 507-508. Disposal of water of condensation collecting in compression chamber and conduits.

Wind Power

Some Long Island Windmills, Edward P. Buffet. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 725-729, 10 figs. Illustrated description of century-old grist mills.

Utilization of Wind Power (Om Udnyttelse af Vindkraften), H. C. Vogt. Ingeniren, year 27, no. 79, Oct. 2, 1918, pp. 521-522.

See also Internal-Combustion Engineering (Gas Engines).

BRICK, CLAY AND STONE

Abrasion Test

Abrasion Test for Mineral Aggregates, H. H. Scofield. Good Roads, vol. 16, no. 12, Sept. 21, 1918, pp. 108 and 110. Suggested modification of Deval test for stone, gravel and similar materials.

See also Testing and Measurements (Sand); Power Generation and Selection (Quarry).

BRIDGES

Concrete Bridges

Recommended practice for Concrete Bridge Construction. Cement & Eng. News, vol. 30, no. 8, Aug. 1918, pp. 30-34, 2 figs. General specifications, prepared by engineers of Portland Cement Assn., based on recommendations of committee on Bridges of Am. Concrete Inst. and on parts of Bul. no. 10 of Illinois State Highway Department, a Manual for County Superintendents of Highways, Resident Engineers, and Inspectors.

Recommended Practice in Design and Construction of Permanent Highway Bridges of Concrete and Steel, John W. Towle. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 144-145. Features of three types: flat slabs or box culverts, girder with two or more heavy stringers; circular or elliptical bridge.

Standard Practice in Concrete Bridge Construction, H. Colin Campbell. Eng. & Cement World, vol. 13, no. 6, Sept. 15, 1918, pp. 11-16, 6 figs. Considerations to determine suitable type of highway bridge for a given location.

Old Bridges

Investigating Old Bridges for Heavier Loading, C. F. Loweth. Ry. Age, vol. 65, no. 17, Oct. 25, 1918, pp. 741-745, 1 fig. Abstract of paper at convention of Am. Ry. Bridge & Building Assn., Chicago, Oct. 1918.

Quebec Bridge

The New Quebec Bridge. Engineering, vol. 106, no. 2750, Sept. 13, 1918, pp. 237-281, 23 figs. A fully illustrated account.

Trunnion Bearing

Repairing a Bascule Bridge Trunnion Bearing. Ry. Age, vol. 65, no. 18, Nov. 1, 1918, pp. 771-772, 3 figs. To insert a new bushing it was necessary to lift an entire span, weighing about 800 tons.

BUILDING AND CONSTRUCTION

Dams

Dams for $20,000,000 Miami Conservancy. Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 276-277, 5 figs. Construction of earth embankments containing up to 4,000,000 yd. with excavated material transported on cars, dumped into sumps, and pumped to place.

Foundations

Reconstructing Foundations of Philadelphia City Hall (II). Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 271-272, 3 figs. Replacement of rubber footings by heavy concrete sectional construction built in sheeted pits 6 ft. long.

Integral Forms

Concrete Construction with Integral Forms. Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 273-274. Utilization of elements of permanent structure eliminating steel and wood temporary forms.

Masonry Building

Guatemala Earthquakes Destroyed All Masonry Buildings, Edward Stuart. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 623-626, 8 figs. Wood and concrete frames stood shocks well; wrecked sanitary services to be rebuilt under direction of Red Cross engineers.

Piers

Building B. & O. R. R., Pier No. 9, Baltimore. Contracting, vol. 7, no. 9, Nov. 1, 1918, pp. 274-275, 3 figs. Replacement of 160 x 850 ft. burned pier and freight house.

The Furness-Withy Company Reinforced Concrete Pier at Halifax, N. S., A. F. Dyer. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 692-695, 5 figs. Work being done in construction of a pier 590 ft. long by 90 ft. wide, carrying a single-story shed 514 ft. by 70 ft.

Shops

New Shop of Standard Steel Car Company. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 465-467, 9 figs. Designed for rapid erection to meet war needs; cost of construction; details of plans.

Tanks

Advice on Oil-Storage Tanks. Petroleum Rev., vol. 39, no. 836, July 27, 1918, p. 60. Manufacture of reinforced concrete tanks: expansion joints. From U. S. Bureau of Mines Bul. (Concluded)

Tank Construction (XXI), Ernest G. Beck. Mech. World, vol. 64, no. 1651, Aug. 23, 1918, pp. 90-91, 5 figs. Formulae and diagrams: side walls of rectangular tanks.

Tower Erection

Some Practical Points in Pole and Tower Erection and Support, Charles R. Harte. Elec. Ry. Jl., vol. 52, no. 12, Sept. 21, 1918, pp. 490-494, 11 figs. Particular reference to erection in marshy ground and the procedure in raising steel towers of different types.

Wind Pressure, Chimneys

Wind Pressure on Tall Chimneys. Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 334-336, 8 figs. Observations of Professor Omori on movement to which top of a chimney is subjected by wind pressure; chimney in question is 567 ft. high.

Compression Load

The Coefficient of Safety of Reinforced and Non-reinforced Concrete Bodies Subject to Centrally and Excentrically Applied Compression Loads (Über den Sicherheitsgrad von Bewehrten und unbewehrten Betonkörpern, die auf zentrischen und exzentrischen Druck beansprucht werden), C. Bach and D. Graf. Armierter Beton, year 11, no. 5, May 1918, pp. 84-90, 4 figs. (To be continued.)

See also Wood (House Finish).

CEMENT AND CONCRETE

Cold Weather

Placing Concrete in Cold Weather. Ry. Signal Engr., vol. 15, no. 216, Sept. 1918, pp. 329-330. Rules for preparing concrete mixtures and means to protect them when freshly placed during periods of cold weather. (Portland Cement Assn. of Chicago.)

See also Railroad Engineering, Steam (Ties).

Disintegration

See Harbor Works.

Floors

On the Distribution of the Energy Stored in Reinforced Concrete Beams and Column-Supported Flat-Slab Floors, Henry T. Eddy. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, pp. 439-448. Analytical interpretation of results obtained in 333 tests carried out by United States Bureau of Standards described in tech. paper 2.

Harbor Works

Reinforced Concrete in Harbor Works, A. F. Dyer. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 277-284 and 289, 11 figs. Causes of disintegration or disruption and means of preventing them; description of two structures. Before Eng. Inst. of Can.

Paving

Concrete for Level Slope Paving. Eng. & Cement World, vol. 13, no. 6, Sept. 15, 1918, pp. 21-22, 9 figs. Results obtained in 500,000 acres reclamation project in Little River Drainage District, Mo.

Piles

Supporting Power of Concrete Pedestal Piles, Henry W. Young. Eng. & Cement World, vol. 13, no. 6, Sept. 15, 1918, pp. 17-19, 3 figs. Methods of forming and results achieved in various soil conditions.

Sections

A Note on the Determination of Excentrically Loaded Concrete Sections (Beitrag zur Bestimmung exzentrisch belasteter Eisenbetonquerschnitte), H. Paeplou. Armierter Beton, year 11, no. 5, May 1918, pp. 90-96, 2 figs.

Determination of Cross Sections of Concrete under One-Sided Compression or Tension with or without Consideration of Tensile Strength of the Concrete (Bestimmung einseitig gedrückter oder gezogener Eisenbetonquerschnitte ohne und mit Berücksichtigung der Betonzugfestigkeit), E. Elwitz. Beton u. Eisen, year 17, nos. 7-8, May 4, 1918, pp. 84-86, 3 figs.

Setting Process

The Mechanism of the Setting Process in Plaster and Cement, Cecil H. Desch. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, pp. 234-235. Attempts to examine two hypothesis and evidence induced in their support, and to indicate the nature of observed discrepancies.

CHEMICAL TECHNOLOGY

Alcohol

Manufacture of Ethyl Alcohol from Wood Waste. Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 204-205, 1 fig. Historical resumé; description of present process; economic considerations; uses of ethyl alcohol.

Ammonia

Enormous Quantities of Ammonia Soon Available. Gas Age, vol. 13, no. 7, Oct. 1, 1918, pp. 317-318. Prospect of yield from Government synthetic plants.

The Oxidation of Ammonia, J. R. Partington. Jl. Soc. Chem. Ind., vol. 37, no. 17, Sept. 16, 1918, pp. 337R-338R, 1 fig. Form of technical converter unit for oxidation by passing ammonia and air over a heated catalyst.

Ammonium Sulphate

The New Plant at the Värta Gas Works in Stockholm, Sweden, for the Production of Ammonium Sulphate and Spirit of Salmiac (Die Neuanlagen auf dem Värtagaswerk in Stockholm zur Herstellung von schwefelsaurem Ammoniak und Salmiakgeist), O. Thümmel. Journal für Gasbeleuchtung, year 61, nos. 18 and 19, May 4 and 11, 1918, pp. 205-210, 14 figs., and pp. 217-220, 2 figs.

Atomic Weights

Revisions of Atomic Weights in 1917 (Les révisions de poids atomiques en 1917), E. Moles. Journal de Chimie Physique, vol. 16, no. 3, Sept. 16, 1918, pp. 350-376. Methods followed and results obtained in each of ten reports; list of publications on subject published in that year.

Boiling Points

Considerations on the Causes for Abnormal Boiling Points. (Considérations sur les causes des points d'ébullition anormaux), A. Berthoud. Jl. de Chimie Physique, vol. 16, no. 3, Sept. 15, 1918, pp. 245-278. Analytical research of influence of molecular association in causing the existence of abnormal boiling points with remarks on Forcrand's experiments with H_2O, ammonia and fluorhydric acid.

Copper Carbonates

The Basic Carbonates of Copper, H. Barratt Dunncliff and Sudarshan Lal. Jl. Chem. Soc., vols. 113 and 114, no. 671, Sept. 1918, pp. 718-722. Examination of a number of samples of commercial copper carbonate showing that the statement that it has same composition as malachite is erroneous; attempt to prepare a basic copper carbonate of approximately constant composition from pure materials.

Explosives

Methods for Routine Work in the Explosives Physical Laboratory of the Bureau of Mines, S. P. Howell and J. E. Tiffany. Department of the Interior, Bureau of Mines, tech. paper 186, 63 pp., 15 tables. Precautions to be observed in storing, handling, and testing explosives; physical examination; tests with ballistic pendulum; tests in gas-and-dust gallery; rate of detonation by Mettegang recorder; conversion tables used in explosive work; list of publications.

Gasoline

Petrol From Your Own Well Gas. Petroleum World, vol. 15, no. 216, Sept. 1918, pp. 371-378, 4 figs. Facts about recovery of gasoline from natural gas by compression and refrigeration; plan of typical direct-connected compressor plant, coils and tower.

Substitute for Lamp Gasoline (Lampenbenzinersatz), A. Krieger. Journal für Gasbeleuchtung, year 61, no. 19, May 11, 1918, pp. 220-221, 1 fig.

Glass

The Significance of Glass-Making Processes to the Petrologist, N. L. Bowen. Sci. Am. Supp., vol. 86, no. 2231, Oct. 5, 1918, p. 221, 1 fig. Processes of manufacturing optical glass and factors making for inhomogeneity in glass. From Jl. of Wash. Academy of Sci.

Hydrocarbons from Coal

The Reactions of Carbonization. Times Eng. Supp., no. 528, Oct. 1918, p. 205. Conclusions drawn from experimental work in preparation of hydrocarbons from coal.

Hypophosphates

On the Preparation of Hypophosphates, R. G. Van Name and Wilbert J. Hull. Am. Jl. of

Sci., vol. 46, no. 274, Oct. 1918, pp. 587-590, 1 fig. Apparatus for preparation by oxidation of yellow phosphorus.

Leather

Recent Developments in Leather Chemistry, H. R. Proctor. Jl. Roy. Soc. of Arts, vol. 66, no. 3440, Oct. 25, 1918, pp. 747-753. Preparing skins or hides for tannage and account of some treatments.

Naphthalene

Description of Direct Determination of Naphthalene in Tar Oil and Raw Naphthalene by the Picric Acid Method (Eine Methode der direkten Naphthalin-Bestimmung in Teer, Teeröl und Rohnaphthalin durch Überführen in Pikrat), Knublauch. Journal für Gasbeleuchtung, year 61, no. 12, Mar. 23, 1918, pp. 134-137.

Determination of Naphthalene in Tars and Tar Oils, Oscar Knublauch. Gas Jl., vol. 143, no. 2888, Sept. 17, 1918, pp. 530-531. Adaptation of author's method of estimating naphthalene by direct titration of picrate with standard alkali to analysis of tars and tar oils. (From Journal für Gas Beleuchtung, vol. 61, pp. 134, 145.)

Nitrogen Oxide

Contribution to the Study of the Velocity of Oxidation of Nitrogen Oxide (Contribution a l'étude de la vitesse d'oxydation du gas oxyde d'azote), E. Briner and E. Fridori. Journal de Chimie Physique, vol. 16, no. 3, Sept. 15, 1918, pp. 279-321, 6 figs. Experimental investigation based on refrigeration of gaseous mixture.

Peat

Sulphite Peat Coal, R. W. Strehlenert. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 269-274. Experiments in preparation of coal from residues of paper sulphite process. From Pulp & Paper Mag. of Can.

Petroleum

Petroleum under the Microscope, James Scott. Petroleum World, vol. 15, no. 216, Sept. 1918, pp. 378-379, 3 figs. Forms of carbon and microstructure of soot. (Continuation of serial.)

Rubber

Apparatus for Drying or Heat Treatment of Rubber. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, pp. 5-6, 1 fig. Apparatus in which material or articles to be treated are adapted to be supported by rotary member which conveys articles through oven.

Gauging the Degree of Vulcanization. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, p. 6. Operation by discontinuing supply of vulcanizing medium when rubber has expanded to an extent corresponding with degree of vulcanization desired.

Substitutes in Germany. Eng. Rev., vol. 32, no. 3, Sept. 16, 1918, pp. 71-72. Graphite economics and substitutes; regenerated rubber and substitutes; fibrous materials. (Continuation of serial.)

Synthetic Rubber. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, p. 400. Substitute prepared in Germany from long continued boiling of isoprene and dimethylbutadiene.

The Rubber Industry, J. Bretland. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 178-179. Brief account of recent scientific methods. From Jl. Roy. Soc. of Arts.

Silicic Acid Gels

Silicic Acid Gels, Harry N. Holmes. Jl. Phys. Chem., vol. 22, no. 7, Oct. 1918, pp. 510-519, 4 figs. Information for preparing special silicic acid gels and report of work on effect of high concentrations of acid mixed with sodium silicate and comparative effect of weak and strong acids on silicic acid.

Sulphuric Acid

Some Data on the Contact Process of Sulphuric Acid Manufacture of the Association of Chemical Factories of Mannheim (Beiträge zur Kenntniss des Kontaktschwefelsäureverfahrens des Vereins Chemischer Fabriken in Mannheim), Hugo Ditz and Franz Kauhäuser. Zeitschrift für angewandte Chemie, year 31, no. 63, Aug. 6, 1918, pp. 149-150.

Water Gas

Discussion of the Chemical Phenomena Underlying the Formation of Water Gas (Ueber die chemischen Grundlagen der Wassergasbildung). Zeitschrift für angewandte Chemie, year 31, no. 57, July 16, 1918, pp. 137-139.

COAL INDUSTRY

Coke

On the Formation of Coke (Sur la formation de coke), Georges Charpy and Marcel Godchot. Comptes Rendus des séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 322-324. Report of experimental work in coking carbon mixtures of different qualities.

Lignites

The Briquetting of Lignites, R. A. Ross. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 357-358. Feasibility of meeting requirements in Saskatchewan and Manitoba by utilizing prepared lignites and sub-bituminous coal.

Panel System of Mining

Suggestions for Improved Methods of Mining Coal on Indian Lands in Oklahoma, J. J. Rutledge and D. Harrington. Department of the Interior, Bureau of Mines, tech. paper, 154, 36 pp., 12 figs. Applicability of different modifications of the panel system to mining coal; list of publications on coal mining.

Screens

A New Type of Screen, M. Raymond. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 589-590, 3 figs. Modified form of American system of rope transmission used for coal screening.

See also Electrical Engineering (Induction Motors).

CORROSION

Iron

The Corrosion of Iron and Steel and its Prevention, Abe Winters. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 185-186. Important factors in process of sherardizing; conditions for commercial work.

Electrolytic Prevention

The Cumberland Electrolytic System for the Prevention of Scale and Corrosion. Elecn., vol. 81, no. 2104, Sept. 13, 1918, p. 419, 1 fig. Description of a system used by British navy and merchant marine to prevent scale and corrosion in boilers and condensers.

ELECTRICAL ENGINEERING

Air Gaps

The Reluctance of an Air Gap Having Slots in Both Opposing Surfaces, F. W. Carter. Elecn., vol. 81, no. 2103, Sept. 6, 1918, pp. 400-401, 3 figs. Comment on article by S. P. Smith appearing in Elecn. Feb. 8, 1918.

Alternators

Armature Reaction and Wave Form of a Single Phase Generator (in Japanese), G. Shimizu. Denki Gakkwai Zasshi, no. 362, Sept. 10, 1918.

Synchronising of Alternators, E. Styff. Elecn., vol. 81, no. 2098, Aug. 2, 1918, pp. 290-291, 4 figs. Abstract of article in Electrotechnische Zeitschrift.

Cables

Causes of Corrosion of Underground Electric Cables (Kabelzerstörungen in der Erde), C. Michalke. Dingler's Polytechnisches Journal, vol. 333, no. 6, Mar. 23, 1918, pp. 43-45. A somewhat general discussion.

Measurement of Power Losses in Dielectrics of Three-Conductor High-Tension Cables, F. M. Farmer. Elecn., vol. 81, no. 2098, Aug. 2, 1918, pp. 288-289, 3 figs. Describing methods used at electrical testing laboratories for measuring dielectric power losses in 10-ft. samples of three-conductor cables subjected to three-phase potential; results given for two specimens of cable, one having low and other high power loss in dielectric.

Central Stations

Reconstruction of a Two-Phase Station. Elec. World, vol. 72, nos. 14 and 17, Oct. 5 and 26, 1918, pp. 644-646, 7 figs., and 788-790, 2 figs. How some problems made necessary by rapid load developments were handled by an Iowa company. Description of furnace equipment and efficiency instruments installed in plant. (First article.)

Conductivity

A New Method for the Determination of Conductivity, Edgar Newbery. Jl. Chem. Soc., vols. 113 and 114, no. 671, Sept. 1918, pp. 701-707, 2 figs. Apparatus in which direct current is used and disturbing effects of polarization at electrodes are eliminated; values obtained for specific conductivity of solutions in mhos. at 25 deg.

Conductors, Heating of

Experiments on Heating of Conductors, Henry C. Horstmann and Victor H. Tousley. Elec. World, vol. 72, no. 15, Oct. 12, 1918, pp. 690-693, 1 fig. Application of tables which show allowable sizes of wire to use with intermittent loads such as are created by skip hoists and crane motors; economy possible in choice of conductor. (Second article.)

D. C. Motors

Operation of Direct-Current Motors in Parallel or Series, Gordon Fox. Power, vol. 48, no. 19, Nov. 2, 1918, pp. 666-668, 6 figs. Considerations leading to use of two motors in parallel are discussed.

Discharges, Disruptive

See Sparks.

Frequency Changers

Load Division Between Synchronous Frequency Changers Operating in Parallel, Quentin Graham. Power, vol. 48, no. 17, Oct. 22, 1918, 3 figs. (Second article.)

Distributing Systems

Electrical Distribution System at Hog Island Shipyard, H. W. Young. Elec. Rev., vol. 73, no. 18, Nov. 2, 1918, pp. 683-685, 5 figs. Extensive distributing system for power and lighting at world's biggest shipyard; circuits largely underground; connected load of 30,000 kw. power and 6000 kw. lighting.

Inductive Interference

Interference by High Power Lines, H. C. Don Carlos. Telephony, vol. 75, no. 17, pp. 28-30. Features of inductive interference by power lines of practical value to rural telephone companies. Before Can. Independent Telephone Convention.

Induction Motors

The Running and Maintenance of Induction Motors at Collieries, L. Fokes. Colliery Guardian, vol. 96, no. 3014, Oct. 4, 1918, pp. 701-702, 4 figs. Selection of motors; electrical considerations; pressure distribution in a star-connected stator with neutral earth—neutral insulated delta—connected stator; stator windings; type of stator best suited for colliery work.

The Slip-Ring Induction Machine (La machine asynchrone à baques), Marius Latour. Revue Générale de L'Electricité, vol. 4, no. 9, Aug. 31, 1918, pp. 291-296, 19 figs. Study of devices proposed by various inventors to increase power factor or regulate speed.

Insulation

The Protection of Electrical Apparatus, P. M. Lincoln. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 346-348. Review of methods by which integrity of electrical insulation may be secured and permanently assured.

Installation and Care of Large Electrical Apparatus for Steel Mills, O. Needham. Elec. Jl., vol. 15, No. 9, Sept. 1918, pp. 333-336, 2 figs. Suggestion in regard to insulation protection, handling, starting and operation of large motors.

Japanese Electrical Exhibition

Big Japanese Electrical Exhibition, A. E. Bryan. Elec. News, vol. 27, no. 20, Oct. 15, 1918, pp. 25-27. General description of exhibit held by Japanese Elec. Soc. to show possible markets and competition to be expected after the war

Magnetism

Normal State and Polarization in Ferro-Magnetic Materials (Normalzustand und Polarization in Ferromagnetikum), Edy Velander. Reprint from Archiv für Elektrotechnik, vol. 6, no. 12, June 22, 1918, pp. 409-437, 32 figs.

Note on a Property of Ferromagnetism (Sur une propriété du ferromagnétisme), Pierre Weiss. Revue Générale de l'Electricité, vol. 4, no. 8, Aug. 24, 1918, pp. 257-258, 2 figs. Magnetization curves of nickel at various temperatures near the Curie point. (From Comptes des Séances de L'Academie de Sciences, July 8.)

Magneto

Ignition Magneto Construction, H. R. Van Deventer. Jl. Soc. Automotive Engrs., vol. 3, no. 4, Oct. 1918, pp. 257-265, 28 figs. Review of features of magneto construction and adjustment.

On the Potential Generated in a High-Tension Magneto, E. Taylor Jones. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 145-169, 6 figs. Theoretical study of phenomena taking place after contacts are separated, and especially of manner in which secondary potential rises and in which its value depends upon the properties of the circuits.

Magnets

An Instrument for Testing Permanent Magnets. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, p. 505, 1 fig. Designed for testing total flux and coercive force.

Outdoor Apparatus

Housing of Outdoor Electrical Apparatus, Roger L. Evans. Quarterly of Nat. Fire Prevention Assn., vol. 12, no. 2, Oct. 1918, pp. 155-156, 1 fig. Objections to use of corrugated iron structures.

Outdoor Distribution Substation in War Times, R. E. Cunningham. Elec. World, vol. 72, no. 14, Oct. 5, 1918, pp. 642-643, 3 figs. Three-phase transformers with automatic pole-top oil switches in primary; innovation found suitable under certain conditions.

Paper, Inductive Capacity

Specific Inductive Capacity of Paper, H. C. P. Weber and T. C. MacKay. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, p. 525, 2 figs. Effect

of temperature and impregnation upon capacity. From Jl. Franklin Inst., Sept. 1918.

Polyphase Motors

Protection of Polyphase Motors with Primary Resistor Type Self-Starters. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 407-408, 1 fig. Connections for typical resistor type self-starter with three-section resistor to give balanced starting conditions.

Rectifiers

Mercury Vapor Rectifier (Vom Quecksilberdampf-Gleichrichter). Schweizerische Bauzeitung, vol. 72, no. 13, Sept. 28, 1918, pp. 117-120, 13 figs.

Remote Control

The Remote Control of Motor Driven Pumps and Compressors, F. M. Nourse. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 133-136, 14 figs. Operation of automatic motor starter.

Resistance

Direct Calculation of the Resistance of Any Number of Conductors Connected in Parallel (Calcul direct de la resistance d'un nombre quelconaque de conducteurs associés en parallèle), E. Haudie. Revue Générale de l'Electricité, vol. 4, no. 10, Aug. 31, 1918, p. 297, 2 figs. Proposes improvement in methods shown in issues of Mar. 23 and June 29.

On the Rate of Change at 100 deg. cent. and at Ordinary Temperatures in the Electrical Resistance of Hardened Steel, E. D. Campbell. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 2, 6 pp., 2 figs. Results obtained with bars 6 millimeters square and 15 cm. long which were suspended and kept for an hour in an electrically heated furnace before being quenched in a large volume of water maintained below 10 deg. cent.

Resonance Transformer Circuits

The Power Factor in the Resonance Transformer Circuit, P. Baillie. Wireless World, vol. 6, no. 67, Oct. 1918, pp. 376-380, 3 figs. Curves showing surtension (L. Ω /R) against cos Φ for different values of *K* (number of semiperiods between two consecutive sparks), plotted from values computed from the formulæ derived in article.

Rotary Converters

The Design Construction and Use of Rotary Converters, C. Sylvester. Electricity, vol. 32, no. 1453, Sept. 13, 1918, pp. 479-480, 7 figs. Explanations of author's experiments illustrating principle of operation of converters. (To be continued.)

Sparks

Photographs of Electric Spark Discharges (Figures de la décharge électrique sur plâques photographiques), Usaboro Toshida. Revue Générale de l'Electricité, vol. 4, no. 8, Aug. 24, 1918, pp. 253-256, 10 figs. Interpretation of formation of Lichtenberg figures on photographic plates, from experiments under various conditions. (From Memoirs of the College of Science, Kyoto Imperial Univ., Mar. 1917.)

Storage Batteries

Thermostatic Generator Control Now Proves Success. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, p. 460, 3 figs. Saving battery life by compensation for atmospheric temperature.

Substations

The Automatic Substation Has Come to Stay, Walter C. Slade. Elec. Ry. Jl., vol. 52, no. 15, Oct. 12, 1918, pp. 651-654. Outlining present status of automatic substation.

See also Outdoor Apparatus.

Transformers

The Economical Loading of Transformer Banks. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 737-738, 2 figs. Giving curves which make it possible to keep most economical number of transformers in service.

Siemens-Halske Automatic Fire Extinguisher for Use in Transformer Installations (Extincteur d'incendie automatique pour cabines de transformateurs, système Siemens et Halske.) Génie Civil, vol. 73, no. 7, Aug. 17, 1918, pp. 135-136, 1 fig. Sends a large volume of carbon dioxide, gives warning and indicates place where fire started. (From Elektrotechnische Zeitschrift, May 23.)

Temperature Indicator for Transformer Winding, V. M. Montsinger, and A. T. Childs. Elecn., vol. 81, no. 2106, Sept. 27, 1918, pp. 450-451, 2 figs. Abstract of article in Genl. Elec. Rev.

Transmission Lines

Transmission-Line Construction of Duquesne Light Company, Thomas R. Hay. Elec. Rev., vol. 73, no. 17, Oct. 26, 1918, pp. 643-646, 5 figs. Difficulties met with in building a 66,000-volt line through a mountainous region.

Trouble Location

Tests for Locating Armature Trouble. Power Plant Eng., vol. 22, no. 21, Nov. 1, 1918, pp. 881-882, 3 figs. All common armature defects detected by one-man bar to bar and ground tests with voltmeter and bank of lamps.

Wiring

Insuring Against Disagreements over Wiring. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 735-737, 4 figs. Forms of contracts used by United Illuminating Co. of Bridgeport, Conn.

See also Factory Management (Electric Motors); Heating and Ventilation (Electric Heating); Power Plants (Power Factor); Safety Engineering (Fire Protection); Steel and Iron (Electric Steel).

ENGINEERING MATERIALS

Aeroplane Fabrics

International Aircraft Standards. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 173-175, 1 fig. Specifications for unmercerized cotton aeroplane fabric (grade A); specifications for mercerized cotton aeroplane fabric (grade B); specifications for unmercerized cotton aeroplane fabric (grade B.).

Aluminum Bronze

Aluminum Bronze as an Engineering Material, Charles Vickers. Machy., vol. 25, no. 2, Oct. 1918, pp. 135-136. Difficulties in casting; use and characteristics; composition; high-tensile aluminum bronzes.

Aluminum Bronzes (Los bronces de aluminio), Jean Escard. Revista de Obras Publicas, year 66, no. 2244, Sept. 26, 1918, pp. 485-492. Their properties, manufacture and industrial utilization.

Asphalt

Standardization of Required Consistency for Asphalt, J. R. Draney. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 309-310. Present variations and needed efficiency.

Bearing Metals

Conservation of Tin in Bronze Bearing Metals, G. H. Clamer. Foundry, vol. 46, no. 315, Nov. 1918, pp. 532-533. Abstract of paper at Inst. of Metals Div. of Am. Inst. of Min. Engrs., Milwaukee, Oct. 1918. Also in Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 773-775.

Some Notes on Babbitt and Babbitted Bearings, Jesse L. Jones. Metal Ind., vol. 16, no. 9, Sept. 1918, pp. 402-404, 5 figs. Brinell tests at progressively increasing temperatures for a lead-base and a tin-base babbitt; process and tool to give accurate and smooth surfaces to bearings. (Inst. of Metals Division of Am. Inst. of Min. Engrs., Milwaukee, October 1918.)

Boiler Plates

Causes of Failure on Boiler Plates, Walter Rosenhain and D. Hansen. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 393-396, 14 figs. Effect of grain growth; alteration of crystalline structure by mechanical deformation; suggested remedies.

Copper

The Alloys of Copper and Zinc: An Investigation of Some of their Mechanical Properties, F. Johnson. Steamship, vol. 30, no. 352, Oct. 1918, pp. 82-83. Report of Brinnell hardness tests as cast and after annealing and tensile tests after annealing. Before Inst. of Metals.

The Effect of Cold Work on Copper, W. E. Alkins. Engineering, vol. 106, no. 2750, Sept. 13, 1918, pp. 283-285, 4 figs. Effect of progressive cold work upon tensile properties of pure copper. Paper before Inst. of Metals, Sept. 1918.

Gun Metal

The Influence of Impurities on the Mechanical Properties of Admiralty Gun-Metal, F. Johnston. Steamship, vol. 30, no. 352, Oct. 1918, pp. 83-84. Review of experimental results of other investigators and account of author's experiments. Before Inst. of Metals.

Hardness

The Resistance of Metals to Penetration Under Impact, C. A. Edwards. Engineering, vol. 106, no. 2750, Sept. 13, 1918, pp. 285-288, 9 figs. Including a note on hardness of solid elements as a periodic function of their atomic weights. Paper before Inst. of Metals.

Precast Concrete Lumber

Precast Concrete Lumber Proves Successful in Mine. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 627-629, 1 fig. Fire resistivity sought in replacing steel and wood or all-timber construction; costs about twice those of timber.

Sand

Sand and Sandstones, James Scott. Stone, vol. 39, no. 10, Oct. 1918, pp. 464-466, 3 figs. Study of minute structure and composition of sand.

Solders

Solders and Substitutes for Lead-Tin Solders, Charles W. Hill. Metal Ind., vol. 16, no. 9, Sept. 1918, pp. 412-415, 3 figs. Some notes on results of experiments conducted in Research Laboratory of Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Strength of Materials

The Strength of Materials, W. Cawthorne Unwin. Times Eng. Supp., no. 528, Oct. 1918, p. 219. Experimental progress in study of mechanical properties of materials, giving brief history of struggle during 18th and 19th centuries to establish the foundations of knowledge of strength of materials and touching on some recent advances in testing machines and methods. Thomas Hawksley lecture.

Tool Steel

Tool Steels. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 174-175. Processes followed to insure proper hardness.

See also Metallurgy; Steel and Iron.

FACTORY MANAGEMENT

Electric Motors

Care and Operation of Electric Motors in Factories, Joseph P. Collopy. Elec. Rev., vol. 73, no. 17, Oct. 26, 1918, pp. 648-662, 4 figs. Proper maintenance of special timely value; good motor location important, points on maintenance of direct-current, induction and synchronous motors.

Employment Manager

Selecting the Employment Manager, Philip Brasher. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 677-678. Requirements of ideal employment manager as seen by author.

The Employment Manager—A New Factor in Industrial Relationship, Edward D. Jones. Am. Gas Eng. Jl., vol. 109, no. 16, Oct. 19, 1918, pp. 361-364. Psychological evolution and present value of this employment. Also in Jl. Engrs. Club of St. Louis, vol. 3, no. 5, Sept.-Oct., pp. 292-301.

Factory Management

The Basis of Scientific Management, M. H. Potter. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 397-399. Question of personnel in problem of management.

Graphic Control of Production

Graphic Production Control, C. E. Knoeppel. Indus. Management, vol. 56, no. 4, Oct., 1918, pp. 284-288, 5 figs. Fifteen laws of control. (Second article.)

Speeding Production by Using Graphic Meters. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 588-589, 6 figs. How a paper products company has installed a system of circuits in order to permit the management to check from executive office any operation going on within the plant.

Shipbuilding Methods

Shipbuilding Methods of the "Eagle" Chaser Factory. Eng. News-Rec., vol. 81, no. 18, Oct. 31, 1918, pp. 788-795, 13 figs. Hull erection divided among seven stations; extensive pre-assembly; rivets heated by electric current; launching platform; automatic platform.

Time Studies

Time Studies for Rate Setting on Gisholt Boring Mills, Dwight V. Merrick. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 289-299. (Fourth article.)

Waste

Possibilities of Salvage and Utilization of Waste, David Currie. Surveyor, vol. 54, no. 1389, Aug. 30, 1918, pp. 99-100. Work being done in U. S.; German methods; possibilities of municipal salvage. (Inst. Cleansing Superintendents.)

See also Industrial Organization; Machine Shop (Drawings); Mines and Mining (Efficiency); Power Plants (Operation).

FORGING

Axle Forging

Shaping the Front Axle Forging on the Nash Motor Car, J. Ledin. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 679-680, 5 figs. Describing design of special bulldozer die for simultaneously performing several distinct operations on automobile front-axle forging.

Shell Forging

Organizing for the Production of Forgings, J. H. Rodgers. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 381-385, 7 figs. Significance of proper forging of shell in subsequent operations; new machine designed for gaging length of billets.

FOUNDRY

Casting

Casting Grey-Iron Piston Rings by Machinery, Ellsworth Sheldon, Am. Mach., vol. 49, no. 18, Oct. 31, 1918, pp. 783-787, 10 figs. Description of the continuous casting of grey-iron piston rings by a machine in which advantage is taken of the action of centrifugal force upon the molten metal.

Electric Furnace

The Electric Furnace in the Steel Foundry, W. E. Moore. Can. Foundryman, vol. 11, no. 9, Oct. 1918, pp. 258-259. Resumé of progress attained during past few years. Before Am. Foundrymen's Assn.

Molding

A New Method of Molding Trench Mortar Shell, H. Cole Estep. Foundry, vol. 46, no. 315, Nov. 1918, pp. 523-525, 6 figs. Two castings are made in each flask; jarring machines are used and production is 350 shells per day.

Modern Methods Facilitate Molding of Large Marine Engine Castings. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 178. Molding of triple-expansion-engine cylinder casting.

Oil Fuel

Use of Oil Fuel in the Foundry in Urgent Exceptional Circumstances, A. E. Plant. Steamship, vol. 30, no. 352. Oct. 1918, pp. 96-97. Account of installation and operation of foundry in connection with repair shops.

Sand

Bettering the Quality of Foundry Sand Mixtures, Henry B. Hauley. Can. Foundryman, vol. 11, no. 9, Oct. 1918, pp. 243-245, 5 figs. Results obtained in experimental investigation undertaken to determine mixtures of old and new sand best adapted to producing good castings. Before Am Foundrymen's Assn.

Much Depends on Securing Suitable Sand. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 176-177, 4 figs. Preparation of quartz and limestone sand for use in molds by Montreal company.

Steel Casting

Acid vs. Basic Steel for Castings, Edwin F. Cone. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 361-363. Uses of acid and basic castings; addition of ferro-alloys; question of oxygen; comparative physical properties; German and American steel castings.

Government Requirements for Steel Castings, E. R. Swanson. Foundry, vol. 46, no. 315, Nov. 1918, p. 538. Physical properties asked by Ordnance Department for three principal grades of steel castings are discussed.

Theory and Practice in Gating and Heading Steel Castings, Ralph H. West. Iron & Steel Inst. of Can., vol. 1, no. 8, Sept. 1918, pp. 338-347, 31 figs. Remarks on general work weighing from 1 to 500 lb., based on author's experience. Before Am. Foundrymen's Assn.

Making Ordnance Steel for the Army and Navy, John Howe Hall. Foundry, vol. 46, no. 315, Nov. 1918, pp. 535-537, Problems of steel castings manufacturers in meeting Government specifications; three essential elements of proper practice. Paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918. Also in Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1084-86.

See also Machinery, Special (Sand-Blast Machinery).

FUELS AND FIRING

Air Preheating

Efficiency of Preheated Air. Power Plant Eng., vol. 22, no. 21, Nov. 1, 1918, pp. 876-877, 3 figs. Advantages and systems of introducing preheated air to furnaces.

Ash

Fusibility of Ash from West Virginia Coals, Walter A. Selvig. Power, vol. 48, no. 16, Oct. 15, 1918, pp. 566-567. Tables of softening temperatures of coal ash from West Virginia Coals.

Waste Due to Excess Ash in Coal. Coal Age, vol. 14, no. 15, Oct. 10, 1918, pp. 692-694, 4 figs. From report of J. G. White Engrg. Corp. to Gano Dunn, Chairman of Engineering Committee of National Research Council.

Waste Due to Excessive Noncombustible in Coal, W. A. Shoudy. Power, vol. 48, no. 19, Nov. 2, 1918, pp. 682-683, 3 figs. From a communication to Chairman of Eng. Committee, National Research Council.

Coal

Calorific Value and Ash Yield of Coal Samples from the Same Seam, T. J. Drakeley. Colliery Guardian, vol. 96, no. 3015, Oct. 11, 1918, pp. 753-794. Paper before Manchester Geological & Min. Soc., Oct. 1918.

Coal Storage

Coal Storage Systems for Power Plants. Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 750-753, 8 figs. Description of general methods of storing and reclaiming coal.

Checking Stored-Coal Temperatures Electrically, Thomas W. Poppe. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 740, 1 fig. Method of detecting incipient fires in piles of stored coal by means of electrical thermometer.

The Storage of Bituminous Coal, E. H. Stoek. Power Notes, vol. 4, no. 10, Oct. 1918, pp. 1-3, 2 figs. Effect of storage in cost to consumer; ventilating a coal pile.

Composite Fuel

Artificial Fuel Compositions, Controlled by Industrial Fuel Corporation. Popular Engr., vol. 10, no. 4, Oct. 1918, pp. 24-25, 2 figs. Patented process to utilize accumulations of anthracite culm and slush.

Control of Heat

Automatic Heat Control for Coal Saving. Metal Worker, vol. 90, no. 16, Oct. 18, 1918, pp. 437-440. Report prepared by Committee of Heating and Ventilating Engineers by request of United States Fuel Administration. Also in Domestic Eng., Oct. 12, 1918, pp. 40-41.

Control Meters, Combustion

Combustion Control Meter. Power, vol. 48, no. 17, Oct. 22, 1918, pp. 599-600, 4 figs. Description of an arrangement of pyrometers developed by Combustion Control Co.

Diagrams of Consumption

Production and Consumption Diagrams in Central Stations, Steam and Others. (Diagrammes de production et diagrammes de consommation relatifs aux centrales électrogènes à vapeur et autres), A. Della Riccia. Revue Générale de' l'Electricite, vol. 4, no. 10, Aug. 31, 1918, pp. 299-310, 6 figs. Fuel consumption of boilers: empirical diagrams applicable to actual cases; conclusions relative to economical use of fuel. (Concluded.)

Firing Methods

Fuel Economy Made Simple, A. Bement. Power, vol. 48, no. 15, Oct. 8, 1918, pp. 524-526. Maintain a hot fire and control rate of combustion by means of draft. Appearance of fire the one comprehensive guide to fireman.

Saving Coal in Boiler Plants, Henry Kreisinger. Department of the Interior, Bureau of Mines, tech. paper 205, 24 pp., 3 figs. Instructions to firemen, engineers and owners of hand-fired plants including: methods of determining stack losses; significance of flue gas analysis; causes of large excess of air and remedy; losses from incomplete combustion; list of publications on the utilization of coal and lignite.

Fuel Conservation

Industrial Fuel Saving. Times Eng. Supp., no. 528, Oct. 1918, p. 204, 1 fig. Points out possibilities and methods.

On the Coal Economy in Steam Power Plant (in Japanese), H. Sekiguchi. Denki Gakkwai Zasshi, no. 362, Sept. 10, 1918.

Gas Firing

Installation for Burning Natural Gas under Boiler, J. J. Griffin. Natural Gas & Gasoline Jl., vol. 12, no. 8, Aug. 1918, pp. 285-286, 3 figs. Illustration and description of setting for low-pressure heating boilers.

Grates

Traveling Grate for Coke and Coke Breeze (Wanderroste für Koksgrus und Koks), Bruno Lepsien. Journal für Gasbeleuchtung, year 61, no. 1, Jan. 5, 1918, pp. 3-8, 9 figs. Description of tests with the Pluto grate and the Nyeboe and Nissen Traveling grate for coke breeze, and the Belani and the Steinmuller grates for coke.

Half-Gas Furnaces

Half-Gas Furnaces with Undergrate Firing (Halbgasöfen mit Unterwindfeuerung), Dingler's Polytechnisches Journal, vol. 333, no. 3, Feb. 9, 1918, pp. 22-23, 6 figs. Description of several German types of so-called half-gas furnaces, i.e., furnaces in which the fuel is partly gasified and partly brought to complete combustion.

Hand-Fired Furnaces

Fuel Economy in Hand Fired Boilers. Power Plant Eng., vol. 22, nos. 21 and 20, Nov. 1, and Oct. 15, 1918, pp. 878-880 and 837-839, 4 figs. Abstract of Circular no. 7, "Fuel Economy in the Operation of Hand Fired Boiler Plants," University of Illinois Engineering Experiment Station. (Second and Third article.)

Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces, H. Kreisinger, C. E. Augustine, and S. H. Katz. Department of the Interior, Bureau of Mines, tech. paper 139, 54 pp., 19 figs. Extension work reported in technical paper 137 which covered higher rates of combustion of 20 to 180 lb. of coal per sq. ft. of grate per hr., to rates below 20 lb. using the same apparatus and following largely equal methods.

Lignite

Burning Lignite with the Mechanical Stoker. Power House, vol. 11, no. 10, Oct. 1918, p. 306. Evaporation test made at the Government of Alberta power station with lignite slack coal.

Lignite Becomes of Importance as a Fuel Resource, S. M. Darling. Am. Gas Eng. Jl., vol. 109, no. 18, Nov. 2, 1918, pp. 415-418. Comparison of carbonized briquets for domestic service with anthracite coal; by-products from lignite. From tech. paper 178 of the United States Bureau of Mines.

Low-Grade Fuels

Low-Grade Fuels. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 191-192. Possible method of disposal. From London Times Eng. Supp.

Peat

Analysis of Canadian Peat. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 253-268. From samples taken in deposits of Nova Scotia, Prince Edward Island, New Brunswick, Quebec, Ontario and Manitoba.

Inorganic Composition of a Peat and of the Plant from which it was Formed, C. F. Miller. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 244-248. Brief description of both products; comparison of composition of peat and saw grass; comparison of losses of three soil-forming materials in their transformation to soils.

The Peat Deposits in Minnesota, E. K. Soper. Jl. Am. Peat Soc., vol. 11, no. 4, Oct. 1918, pp. 227-243, 8 figs. Quantity, quality, and uses to which they are best adapted. Reprinted from Economic Geology, vol. 12, p. 526.

Petroleum

Petroleum as Combustible (El petroleo como combustible), J. R. Pérez. Revista de la Sociedad Cubana de Ingenieros, vol. 10, no. 9, Sept. 1918, pp. 523-531. Physical and chemical properties; refinement and uses; description of burners.

Unmined Petroleum Supply Limited, Allen Sinsheimer. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 491-493, 3 figs. Extent of supply made by United States National Museum following compreheisive survey of situation.

Powdered Coal

Powdered Coal Substituted for Fuel Oil at Seattle. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, pp. 529-531, 4 figs. Description of equipment for burning powdered coal at Puget Sound Traction Light & Power Co.'s central heating plant.

Pulverized Coal Tests Conducted at Milwaukee. Elec. Rev., vol. 73, no. 16 and 17, Oct. 19 and 26, 1918, pp. 615 and 658-659, 1 fig. Details of installation in Milwaukee. Efficiency of over 85 per cent obtained. Also in Elec. World, vol. 72, no. 16. Oct. 19, 1918, pp. 744-745; Ry. Rev., vol. 63, no. 17, Oct. 26, 1918, pp. 606-607, 2 figs; Ry Age, vol. 65, no. 15, Oct. 11, 1918, pp. 667-669, 2 figs; Power, vol. 48, no. 16, Oct. 15, 1918, pp. 556-559, 4 figs.

Smokestack Losses

Apparatus to Measure Chimney Loss and the Elements which Constitute It. (Appareil de mesure de la perte à la cheminée et des éléments constitutifs de cette perte).) Marcel Chopin. Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 335-338, 2 figs. Suggests instrument registering temperature and amount of carbonic acid.

Waste Gases

Use of Waste Gases for Steam Generation, J. B. C. Kershaw. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 591-594. Study of progress and records of past few years.

Wood Burning

New Wood-Burning Station of Northwestern Electric Company. Elec. Rev., vol. 73, no. 15, Oct. 12, 1918, pp. 573-574, 2 figs. Details of construction and equipment.

See also Chemical Technology (Peat); Coal Industry; Foundry (Oil Fuel); Power Generation and Selection (Waste Heat); Mines and Mining (Oil Shales).

FURNACES

Electric Furnaces

The Development of Stellite, Elwood Haynes. Iron Age, vol. 102, no. 15, Oct. 10, 1918, pp. 886-888, 3 figs. Melting problems solved by Snyder Electric Furnaces which displaced gas-fired crucibles; three furnaces have capacity of over four tons in eleven hours.

Gas Ovens

Experiences with Horizontal Slot Ovens, Henry W. Douglas. Gas Age, vol. 13, no. 7,

Oct. 1, 1918, pp. 307-308. Installation of six oven benches containing three ovens each. Before Michigan Gas Assn.

See also Foundry (Electric Furnaces); Steel and Iron (Electric Steel).

HANDLING OF MATERIALS

Steel Plant

Canadian National Steel Plant, W. F. Sutherland. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 169-174, 13 figs. Handling of materials, arrangement of loading platform bins, installation of furnaces and other features.

HEATING AND VENTILATION

Electric Heating

Industrial Applications of Electricity, Dwight D. Miller. Elec. World, vol. 72, no. 15, Oct. 12, 1918, pp. 693-695, 2 figs. It is predicted that electric heating load will eventually surpass motor load; convenience of control of electrically generated heat results in improved product and increased production. (First article.)

Hot-Water Service

Standards of Central Station Hot Water Heating Service. Heat. & Vent. Mag., vol. 15, no. 10, Oct., 1918, pp. 31-36. Established by Public Service Commission of Indiana under date Aug. 3, 1918.

Public-School Ventilation

The Movement to Eliminate Mechanical Ventilation in New York City's Public Schools. Heat. & Vent. Mag., vol. 15, no. 10, Oct. 1918, pp. 47-49. Tests by Department of Health of classrooms in twelve rooms is basis for this action. A résumé of the tests.

Vacuum-Vapor System

Fuel Saving Heating Systems, Alfred G. King. Domestic Eng., vol. 84, no. 11, Sept. 14, 1918, pp. 390-392 and 423, 4 figs. How a vacuum-vapor heating system is installed and proves effective in fuel economy.

See also Mines and Mining (Ventilation).

HOISTING AND CONVEYING

Bonner Rail Wagon System

Freight Transportation Without Rehandling. Elec. Ry. Jl., vol. 52, no. 15, Oct. 12, 1918, pp. 658-659, 5 figs. Bonner rail wagon system aims to reduce cost and time of freight haulage by using containers on wheels which do not require warehouse facilities.

Conveyor, Coal

A Reciprocating Underground Coal Conveyor, J. F. K. Brown. Coal Age, vol. 14, no. 15, Oct. 10, 1918, pp. 682-684, 2 figs. A conveyor for use in coal beds where inclination is such that cars may be handled only with difficulty.

Cranes

Safety Code for the Operation of Electric Cranes. Power House, vol. 11, no. 10, Oct. 1918, p. 309. Formulated by Iron and Steel Elec. Engrs.

Grain-Unloading Plants

Portable Pneumatic Grain Unloading Plant. Engineer, vol. 126, no. 3266, Aug. 2, 1918, pp. 94, 95, 7 figs. Portability the interesting feature, the plant being set upon railway trucks; drawings and descriptions.

Mine-Car Dumping

Shipping Facilities at the World's Largest Coal Mine, R. W. Mayer. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 586-588. A mine producing 7000 tons of coal per day with mine cars dumped at rate of one every 12 sec.

Tipple

Valley Camp Coal Co.'s Tipple at Parnassus, Penn., George S. Jaxon. Coal Age, vol. 14, no. 13, Sept. 26, 1918, pp. 582-585, 11 figs. Designed to make four sizes of coal; a conveyor designed to facilitate cleaning the tracks under the tipple of spillage from the cars after the day's run.

Tractor-Trailer, Freight Handling by

Freight Handling by Tractors Found Economical. Eng. News-Rec., vol. 81, no. 16, Oct. 17, 1918, pp. 720-721, 2 figs. Tractor-trailer system replaces hand trucking and reduces costs at large L. C. L. freight station at Chicago.

See also Handling of Materials; Marine Engineering (Trimming Conveyor); Motor-Car Engineering (Crane Tractors); Transportation.

HYDRAULIC ENGINEERING

Artesian Wells

Artesian Wells for Water Supply, with Special Reference to the Artesian Wells of Wisconsin, W. G. Kirchoffer, Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 136-138. Velocity of flow in sandstone formations; mineral content found in ground and artesian waters.

Brazil

Water Power in Brazil. Times Eng. Supp., no. 528, Oct. 1918, p. 211. Prospects of utilization.

British Empire

Water Powers of the Empire. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, pp. 383-386 and 391-392. Preliminary report of Water Power Committee appointed by Conjoint Board of Scientific Societies of Great Britain. (To be concluded.)

Dams

Calaveras Dam Slide. Report of Government Experts, D. C. Henry and C. H. Swigart. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 26-28, 2 figs.

Interconnected Plants

Economy of Water Effected by Intercommunication, R. H. Halpenny. Elec. World, vol. 72, no. 18, Nov. 2, 1918, pp. 828-831, 3 figs. Two hydroelectric companies, operating plants on the same stream, are interconnected through a 6000-kva. transformer; difference in load characteristics permits increasing total load with same flow of water.

Niagara Falls

Canada Rushing Huge Niagara Development as a War Conservation Measure. Eng. News-Rec., vol. 81, no. 18, Oct. 31, 1918, pp. 801-805, 9 figs. Report of construction work in digging a 8½ mile canal around falls.

Penstock Pipes

Saving the Waste in Penstock Pipe Design, B. F. Jakobsen. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 413-415, 2 figs. Points out manner of proportioning economically penstock pipes and transmission lines.

Turbines, Hydraulic

See Waterwheels.

Water Measurement

Measurement of Water by Means of Cipoletti Weir (Wassermessung mittels des Ueberfalls von Cipoletti), Dinglers' Polytechnisches Journal, vol. 333, no. 7, April 6, 1918, pp. 58-59. Abstract of a paper by Professor Luedecke in the German publication, Der Kulturtechniker, 1917, no. 4. Derivation of formulæ for determination of water discharge by the Cipoletti Weir. In the present article the logarithmic scale is applied and formulæ are derived.

Water Power

Fundamental Principles in the Development of Water Power, David R. Shearer. Power, vol. 48, no. 16, Oct. 15, 1918, pp. 563-565, 4 figs. Points to be considered in developing water power of a stream; explanation of fundamental calculations.

Water Supplies

The Development of Water Supplies for Rural Communities in Saskatchewan, E. L. Miles. Eng. & Contracting, vol. 50, no. 11, Sept. 11, 1918, pp. 254-255, 3 figs. Supply from springs; reservoirs; instructions for the construction of dams; dugout type of reservoir. (Engrg. Inst. of Canada.)

Waterwheels

Tests on a 715-Hp. High Speed Water Turbine. (Ueber Leistungversuche an einer schnell laufenden Wasserturbine von 715 PS), W. Schmid. Schweizerische Bauzeitung, vol. 72, no. 14, Oct. 5, 1918, pp. 129-131, 4 figs.

Waterwheel Types and Settings, David R. Shearer. Power, vol. 48, no. 19, Nov. 2, 1918, pp. 670-672, 11 figs. Various forms of waterwheels and turbines with regard to direction of flow of water, position of shaft and casing of wheel.

Waterworks

New Water Works in the City of Trier (Das neue Grundwasserwerk der Stadt Trier im Moselthal bei Kenn), Wahl. Journal für Gasbeleuchtung, year 61, nos. 7, 8, 9 and 10, Feb. 16 and 29, Mar. 2 and 10, 1918, pp. 77-81, 8 figs., pp. 85-89, 3 figs., pp. 100-104, 8 figs., and pp. 111-117, 6 figs. Extensive description with illustrations.

The Economics of Public Utilities Extensions, J. W. Ledoux. Am. City, vol. 19, no. 4, Oct. 1918, pp. 293-295. Discussion of proper relation of estimated revenue to estimated cost of water-works extension or improvement.

See also Mines and Mining (Water in Mines); Power Plants (Hydroelectric); Safety Engineering (Water Mains.)

INDUSTRIAL ORGANIZATION

Accounting

Cost Accounting to Aid Production, C. Charter Harrison. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 273-282, 2 figs. Application of scientific management principles. (First article.)

Relation of Statistics and Accounting in Industrial Management, Milton B. Ignatius, Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 312-315. Tells what matters should have statistical study and gives numerous practical points in regard to organizing work and selecting statistician.

Drafting Room

Simple Drafting Room Methods, G. F. Hamilton. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 301-304, 15 figs. How a machine building plant systemizes its drafting work.

Inspection

Inspection and Quality Control, F. E. Merriam. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 305-311, 5 figs. Practical application of underlying principles; outlines organization of an inspection department, points out divisions of work, treats of selection and training of inspectors, tells how to uphold standards, and gives suggestions on selection and application of inspection gages.

Reconstruction

Reconstruction Problems from an Engineering Standpoint. Jl. Engrs. Club of St. Louis, vol. 3, no. 5, Sept.-Oct. 1918, pp. 305-308. Suggestions to engineering organizations.

INTERNAL-COMBUSTION ENGINEERING

Constant-Pressure Engines

Fuel Admission Valve of Constant Pressure Internal Combustion Engines (Das Brennstoffventil der Gleichdruckmaschine). Dinglers polytechnisches Journal, vol. 333, no. 10, May 18, 1918, pp. 85-86, 3 figs.

(See also Oil Engines.)

Diesel Engines

Operation of Diesel Engines in China, Harold B. Wilson. Motorship, vol. 3, no. 11, Nov. 1918, pp. 9-10, 4 figs. Data concerning operation of five different Diesel makes under author's charge. (To be continued.)

The Diesel Engine; its Fuels and its Uses, Herbert Haas. Department of the Interior, Bureau of Mines, bul. 156, petroleum technology no. 44, 130 pp., 73 figs. Details of three general types, explosion, Diesel and Sabathé; methods permitting use of coal-tar and coal-tar oils; classification, composition and properties of fuels; formulae for computing fuel cost; examples of successful use of Diesel engines; selected bibliography. Also in Gas Eng., vol. 20, no. 11, Nov. 1918, pp. 513-519, 4 figs.

The True Status of Diesel Engines, J. C. Shaw. Marine Rev., vol. 48, no. 10, Oct. 1918, pp. 449-450. Remarks on rational design of an oil engine (Aug. issue) in reference to statements about ignition disturbances.

Gas Engines

1500-hp. Gas Blowing Engine. Engineer, vol. 126, no. 3271, Sept. 6, 1918, pp. 207, 4 figs. Principally drawings of engine.

Governors

The Design of Governors, with Special Reference to Small Diesel Engines, Arthur B. Lakey. Proc. Engrs. Soc. of Western Pa., vol. 34, no. 6, July 1918, pp. 461-481, 12 figs. and (discussion) pp. 482-488, 1 fig. Points out shortcuts in design and adjustment of certain types of centrifugal governors, and shows need of certain auxiliary apparatus to secure improved smoothness of running in the case of Diesel engines of small power, or with only small flywheels.

Governing

Investigation of Gas Engine Governing (Untersuchung einer Gasmaschinenregelung), A. Gramberg. Dinglers Polytechnisches Journal, vol. 333, no. 7, Apr. 6, 1918, pp. 53-55, 5 figs. Data of an extensive experimental investigation.

High-Speed Engines

High-Speed Internal Combustion Engines, Harry R. Ricardo. Mech. World, vol. 64, nos. 1645, 1649 and 1650, July 12, Aug. 9, and Aug. 16, 1918, p. 17, 7 figs, p. 69, 1 fig., and pp. 81-82, 6 figs. July 12: Comparative wear and tear of slow- and high-speed engines. Aug 9: Factors affecting volumetric efficiency and possibilities of increasing it, theories explaining detonation or "pinking." (Northeast Coast Instn. of Engrs. & Shipbuilders.)

Indicator Diagrams

The Theoretical Indicator Diagram, O. A. Malychevitch. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 499-502, 2 figs. Method of predetermining gas temperatures and pressures for various points in engine cycles from chemical composition of charge and physical properties of components.

Oil Engines

Faults in the Design of Some Surface-Ignition Oil Engines, W. J. Woodcock. Motorship, vol. 3, no. 11, Nov. 1918, p. 16, 1 fig. An operator's idea of an improved motor.

New Type of Marine Oil Engine. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 563-566, 6 figs. Two-cycle Weiss engine; simple injection system. Description of engine and discussion of scavenging.

Oil-Engine Sprayers or Pulverizers, A. H. Goldingham and C. T. O'Brien. Motorship, vol. 3, no. 11, Nov. 1918, pp. 14-15, 5 figs. Details of various types of injection-valves. (Concluded from Sept. issue.)

The Heavy Oil Engine, Charles E. Lucke. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 579-583. Discussion of factors to be considered in design; small demand as yet for heavy oil types; future possibilities. Paper before Engrs. Club of Philadelphia, Jan. 1918.

The Heavy Oil Engine, Chas. E. Lucke. Popular Engr., vol. 10, no. 4, Oct. 1918, pp. 17-18 and 22. Presentation of ideas involved in development up to present time and consideration of possibility of change in near future. Before Engrs. Club of Phila.

Power Output

The Increase of Power Output, Emil Schimanek. Aerial Age, vol. 8, no. 4, Oct. 7, 1918, pp. 170-173 and 193, 20 figs. Increase of power output in internal combustion by (1) increasing thermal efficiency, (2) increasing number of working strokes in unit-time, or (3) increasing air charge in working cylinders. Translated from Zeitschrift des Vereines Deutscher Ingenieure.

Pulverizers

See Oil Engines.

Sleeve-Valve Engine

Tests of a Sleeve Valve Engine. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 494-498, 12 figs. Monograph diagram, horsepower and torque curves.

Sprayers

See Oil Engines.

See also Marine Engineering (Motor Ships.)

LABOR

Aliens

See Americanization.

Americanization

Making Americans on the Railroad, Samuel Rea. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 673-676. Methods adopted and results achieved in persuading and fitting foreign-born employees of Penn. R. R. to become loyal and useful citizens.

Apprenticeship

Cooperative Management—The Apprentice, Arthur F. Johnson. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 567-568. Apprentice a vital essential in industry; should be given liberal education; freedom of shop important for his rounded education.

Bonus System

Fuel Bonuses in Central Stations (Prime à l'économie de charbon dans les stations centrales—thermiques), L. Conge. Revue Générale de l'Electricité, vol. 4, no. 10, Aug. 31, 1918, pp. 319-320, 1 fig. How a bonus system may be established and employees made to coöperate in the economization of fuel.

Cooperation

The Babson Conference on Coöperation. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 749-752. Account of conference, fifth annual, held at Wellesley Hills, Mass., Sept. 1918, on profit-sharing, labor turnover and efficiency, United States Employment Service, and experience in collective bargaining and in dealing with unions.

Employee Representation

Bethlehem Plan of Employee Representation. Iron Age, vol. 102, no. 17, Oct. 24, 1918, pp. 1020-1022, 2 figs. Monthly committee meetings and annual conferences to consider wages, working conditions, housing and all other questions of mutual interest.

Housing

Lodging House for Thirty Men Costs $11,000. Elec. Ry. Jl., vol. 52, no. 14, Oct. 5, 1918, pp. 615-616, 5 figs. Details of a lodging house built by Connecticut Co. at Waterbury, Conn.

Soldiers Discharged

The Employment of Discharged Soldiers. Times Eng. Supp., no. 528, Oct. 1918, pp. 201-202. Methods by which engineering trades may help to solve problem.

Supervision

The Mechanical Department Supervision Problem, Frank McManamy. Ry. Age, vol. 65, no. 17, Oct. 25, 1918, pp. 729-731. Dilution of quality of labor has increased need of more and better supervision. Abstract of paper before New York Railroad Club.

Training

How Best to Educate the Road Foreman, the Engineer and the Fireman, Frank J. Barry. Proc. Central Ry. Club, vol. 26, no. 4, Sept. 1918, pp. 442-448 and (discussion) pp. 448-466. Consideration of different methods and observations on matters having bearing on character of results education is likely to produce.

Training Minor Executives in a Large Shoe Factory, Roy Willmarth Kelly. Indus. Management, vol. 56, Oct. 1918, pp. 316-319, 2 figs.

Training School for Machine Operators. Iron Age, vol. 102, no. 17, Oct. 24, 1918, pp. 1011-1012, 2 figs. Special department at Timken plant gives better results than breaking in in regular departments.

Turnover

Keeping Track of Labor Turnover, E. H. Fish. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, pp. 445-446. Suggests careful compilation and analysis of turnover records in plants where semi-skilled men must be trained to meet labor needs.

Women

Introducing Woman Labor into the Shop, M. C. Hobart. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 769-770. Experience of a Chicago firm in this new departure.

Manufacture by Women. Times Eng. Supp., no. 528, Oct. 1918, p. 217. Account of exhibitions of women's work formed by Ministry of Munitions through Technical Section of its Labor Supply, at Liverpool.

Putting Women Into the Machine Shop, F. L. Prentiss. Iron Age, vol. 102, no. 15, Oct. 10, 1918, pp. 892-896, 2 figs. Short probationary period successful in Cleveland plants; qualities in which women excel; reduced labor turnover.

Solving New Haven's Man-Power Problem, Charlton L. Edholm. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 721-723, 2 figs. Account of effort to secure services of women of New Haven in munitions shops of Winchester Repeating Arms Co.

The Demand for and Supply of Women Workers. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 490-491. Contrast between percentages of American and English women now employed.

The Renumeration of Male and Female Labor. Eng. Rev., vol. 32, no. 3, Sept. 16, 1918, pp. 68-69. Discussion of relative efficiencies of male and female labor in the light of extensive experience in engineering shops.

Women in Central Station Work, J. W. Alexander. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 392-393, 5 figs. Account of work being done by women as power plant operators and meter readers.

LEGAL

Building Law

Puzzling Variations in Important Building-Law Clauses, R. Fleming. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 579-581. Requirements as to stresses; specified wall thickness often wasteful; wind bracing neglected; interesting special features.

See also Electrical Engineering (Wiring); Safety Engineering (Dangerous Tools), (Grinding Tools.)

LIGHTING

Dispersion of Light

Dispersion of Light as a Means of Reducing the Surface Brightness of Artificial Illuminants (Die Streuung des Lichtes als Mittel zur Verringerung der Flächenhelle künstlicher Lichtquellen), N. A. Halbertsma. Dingler's polytechnisches Journal, vol. 333, no. 9, May 4, 1918, pp. 76-77, 2 figs.

Better Lighting of Glass Works and Potteries, F. H. Bernhard. Elec. Rev., vol. 73, no. 15, Oct. 12, 1918, pp. 567-572, 6 figs. Eighth of a series of articles on improvement in lighting in the industries.

Lighting of Rubber-Goods Factories, F. H. Bernhard. Elec. Rev., vol. 73, no. 17, Oct. 26, 1918, pp. 653-657, 5 figs. Ninth of a series on lighting in industries.

Factory Lighting

Terminal Shop and Classification Yard Lighting. Ry. Rev., vol. 63, no. 18, Nov. 2, 1918, pp. 625-627, 5 figs. General discussion of modern shop and yard lighting systems through the use of the flood system. Committee report before Convention of Assn. of Ry. Elec. Engrs., by J. E. Gardner.

House Lighting

The Lighting Ration in Practice. Illuminating Engr., vol. 11, no. 7, July 1918, pp. 177-181. Suggests how lighting rations under household fuel and lighting order may be expected to apply to two typical houses, having respectively six and twelve rooms.

Illuminants

Experimental Comparison of the Lighting Efficiency of Various Artificial Sources of Illumination (Zur Beurteilung der Beleuchtungswirkung künstlicher Lichtquellen), W. Bertelsmann. Journal für Gasbeleuchtung, year 61, no. 6, Feb. 9, 1918, pp. 61-64.

Lighting Economies

Possible Wartime Lighting Economies. Elec. News, vol. 27, no. 21, Nov. 1, 1918, pp. 23-26. Report of committee on war service of the Illuminating Eng. Soc.

Mantle Lights

A Physical Study of the Welsbach Mantle, H. E. Ives, E. F. Kingsbury, and E. Karrer. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, pp. 401-438, 15 figs. Details of theory of ordinary mantle, and application of Rubens methods, as well as other new methods, to mantles composed of other oxides and oxide mixtures. (To be continued.)

Urges Use of Pilots with Mantle Lamps as Fuel Conservation Measure. Am. Gas Eng. Jl., vol. 109, no. 16, Oct. 19, 1918, pp. 367-371. Report of Illuminuating Eng. Soc. giving rules limiting use of artificial light to minimum necessary number of hours per day and promoting most efficient use of artificial light during those hours.

Photometers

Improvements in the Spherical Photometer, R. von Voss. Elecn., vol. 81, no. 2104, Sept. 13, 1918, pp. 418-419, 1 fig. Abstract of an article in the "Elektrotechnische Zeitschrift," no. 52, 1917.

Street Lighting

War-Time Street Lighting Economy. J. R. Cravath. Am. City, vol. 19, no. 4, Oct. 1918, pp. 303-304, 2 figs. Indicates where reductions can be made. From compilations of data and opinions of illuminating engineers throughout the country presented before Illum. Engrs. Soc.

See also Standards and Standardization (Lamp Voltages.)

LUBRICATION

Cutting Lubricants

Cutting Lubricants. Times Eng. Supp., no. 528, Oct. 1918, p. 218. Memorandum issued by Department of Scientific and Industrial Research, prepared by a committee of department in connection with a survey of field for research on lubricants and lubrication.

Explosion Engines

Lubrication of Explosion Engines. Petroleum World, vol. 15, no. 216, Sept. 1918, pp. 380-381. Action of oil and suggestions on selection of lubricant. (Concluded.)

Marine Engines

The Lubrication of Marine Engines. Shipbuilding & Shipping Rec., vol. 12, no. 12, Sept. 19, 1918, pp. 277-278. Principles to be followed regarding place of application of oil; considerations on frequency and pressure.

Viscosity of Oils

Viscosity and Constitution of Lubricating Oils. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, p. 240. Review of conclusions obtained by various experimenters.

MACHINE DESIGN

Cams

Cam Profiles (II), Wm. Ker Wilson. Mech. World, vol. 64, no. 1649, Aug. 9, 1918, pp. 66-67, 7 figs. Displacement curves of cam giving simple harmonic motion to roller and of cam giving uniform acceleration to roller.

MACHINE PARTS

Bearings

Life of Ball Bearings (Ueber Lebensdauer von Kugellagern), Henry Gärtner. Dingler's Polytechnisches Journal, vol. 333, no. 5, Mar. 9, 1918, pp. 35-38, 4 figs. Safe loads on ball bearings and the life of ball bearings under various conditions of loading and maintenance.

Roller Bearings for Machine Shop Equipment, Edward K. Hammond. Machy., vol. 25, no. 2, Oct. 1918, pp. 115-122, 14 figs. (Fourth article.)

The "Dragon" Ball Bearing. Can. Machy., vol. 20, no. 17, Oct. 24, 1918, pp. 475-476, 4 figs. Double row ball bearings, manufactured in standard single row widths, in each instance containing approximately double the number of balls of corresponding single row bearing, the two rows of balls being staggered in relation to each other.

Bolts

On the Strength of Bolts in Aeroplane Structures, John Case. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 158-162, 8 figs. Analytical computation of distribution of load between several bolts bearing same load in (1) strap joint under direct load, (2) single lateral force divided between several bolts, (3) when there is bending. (Concluded.)

Stress Distribution in Bolts and Nuts, C. E. Stromeyer. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 589-591, 4 figs. Character and analysis of strains in butt straps; instrument for ascertaining difference in thread pitch. Paper before Inst. of Naval Architects, London, March 1918.

Flywheels

Disastrous Flywheel Explosion at Chicago. Power, vol. 28, no. 15, Oct. 8, 1918, pp. 516-519, 6 figs. Details of an accident to a 24 by 42-in. 500 hp. Corliss engine.

Keyways

Figuring Keyways on Shafts, John Havekost. Machy., vol. 25, no. 2, Oct. 1918, pp. 152, 1 fig. A collection of formulæ.

Sprockets

Sprocket Design, Theory and Practice, Wiley M. Free. Machy., vol. 25, no. 2, Oct. 1918, pp. 147-150, 4 figs. Factors controlling designing of sprockets for malleable chain drives, and action of chain on driving and driven sprockets under different conditions.

See also Standards and Standardization (Gearing.)

MACHINE SHOP

Balancing

Methods of Balancing Rotors, C. C. Brinton. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 349-352, 9 figs. Static and dynamic balances; balancing machines.

Chain Cables

Memorandum Regarding the Manufacture of Cast-Steel Chain Cables. Steamship, vol. 30, no. 352, Oct. 1918, pp. 90-91. Report of Committee of Lloyd's Register; summary of previous attempts and present position; testing of cast-steel chains. Also in Practical Engr., vol. 58, no. 1643, Aug. 22, 1918, pp. 91-92. (To be continued.)

Chain Making

The Manufacture of a Diamond Transmission Chain, J. V. Hunter. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 643-647, 13 figs. Description of some automatic and semi-automatic machines used in manufacture of transmission chain.

Drawings

A Study of Drafting Room Errors, R. Fleming. Eng. & Contracting, vol. 50, no. 17, Oct. 23, 1918, pp. 378. Most common and most expensive errors made in structural drafting.

Representation of Screw Threads and Dimensioning. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, pp. 291-294, 27 figs. Rules for dimensioning drawings.

Gages

Developing a Gaging System for Small Arms and Heavy Ordnance, Erik Oberg. Machy., vol. 25, no. 2, Oct. 1918, pp. 93-107, 9 figs. First of a series describing principles involved and procedure followed in developing gaging systems for interchangeable manufacture. Based upon experience of Pratt & Whitney Co. in furnishing gaging equipment for small arms and heavy ordnance work.

Rules for Computing Gage Tolerances, D. Douglas Demarest. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 332-334, 3 figs. Three simple rules show how to compute overall length, mean length and mean depth of finish.

Gage Making

Gage Making in a Shell Plant, Franklin D. Jones. Machy., vol. 25, no. 1, Sept. 1918, pp. 1-6, 19 figs. Sixth of series of articles describing methods employed in a plant making United States 75-mm. shell.

Gear Cutting

Electric-Railway Motor Pinion Making. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 648-650, 7 figs. Describing various steps in manufacture of gears and pinions for electric-railway motors.

Heat Treatment

Annealing Cold-Rolled Aluminum Sheet by Abbreviated Exposures at Various Temperatures, Robert J. Anderson. Page's Eng. Weekly, vol. 33, no. 734, Oct. 4, 1918, pp. 160-161. Report of experiments. Before Inst. of Metals.

Hosiery-Machine Making

Making Hosiery-Machine Parts, Robert Mawson. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 709-710, 5 figs. Sequence of operations in milling certain members of hosiery machines as practised by Hemphill Mfg. Co., Pawtucket, R. I.

Irregular-Shaped Work

Generating Cams and Irregular-Shaped Work, Douglas P. Hamilton. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 737-740, 12 figs. Outlining possibilities of producing in gear shaper and on a commercial basis cams and other irregular forms.

Moving-Picture-Machine Making

Making a Moving Picture Machine, M. E. Hoag. Am. Mach., vol. 49, nos. 16 and 17, Oct. 17 and 24, 1918, pp. 718-720, 16 figs., 759-761, 10 figs. The light shutter. (Second and third article.)

Screw Work

Production Problems of Aircraft Bolts, Screws and Nuts, W. H. Sheahan. Aviation, vol. 5, no. 6, Oct. 15, 1918, pp. 363-365, 4 figs. Gaging machines.

Tractor Manufacture

Manufacturing the Caterpillar Tractor, Frank A. Stanley. Am. Mach., vol. 49, nos. 17 and 18, Oct. 24 and 31, 1918, pp. 745-747, 5 figs., and 801-804, 9 figs. General features. (First and second article.)

Truck Making

Assembling the Liberty Truck, M. E. Hoag. Am. Mach., vol. 49, no. 18, Oct. 31, 1918, pp. 813-815, 11 figs. Description of methods used in a Western factory.

Welding

Cutting Test Pieces from Shells. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 183, 1 fig. General details of machine operating by oxy-acetylene torch.

Fusion Welding Fallacies, S. W. Miller. Machy., vol. 25, no. 2, Oct. 1918, pp. 123-124, 2 figs. (Fourth article.)

New Work for the Welding Engineer, C. W. Brett. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 170-171, 4 figs. Shows application of welding to an aluminum airplane engine crankcase and to a cast-iron cog wheel.

Practical Data Upon Electrical Spot Welding, G. A. Hughes and R. H. Pool. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 742-744, 2 figs. Power consumption, strength of welds and speed with which welds can be made determined for various kinds of plates.

Selection and Application of Electric Arc Welding Apparatus, A. M. Candy. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 337-346, 25 figs. Requisites for alternating-current arc welding and direct-current arc welding; constant current versus constant potential generators; protective equipment and accessories; welding principles; selection of electrodes; gas versus electric arc.

Some Notes on the Resistance Method of Electric Welding, G. W. Stubbings. Mech. World, vol. 64, no. 1654, Sept. 13, 1918, p. 124. Manner of applying electric supply to weld in case of direct current and also in case of alternating current.

The Oxy-Acetylene Process for Welding Boiler-Plate, H. A. Boyd. Mech. World, vol. 64, no. 1649, Aug. 9, 1918, pp. 69-70. Result of tests made of three pieces taken from new boiler-plate. (Cal. Safety News.)

The Practice of Oxy-Acetylene Welding, J. T. Morton. Aeronautics, vol. 15, no. 253, Aug. 21, 1918, pp. 165-169, 12 figs. Suggestions regarding selection of burners, determination of correct proportions of burning gases in flame and other details of process.

See also Engineering Materials (Tool Steel); Railroad Engineering, Steam (Shops); Safety Engineering (Punch Presses); Steel and Iron (Quenching); Machinery, Special (Sand-Blast Machinery).

MACHINE TOOLS

Second-Hand Tools

The Buying of Second-Hand Machine Tools, Donald A. Hampson. Can. Machy., vol. 22, no. 16, Oct. 17, 1918, pp. 466-467. Importance of determining age of machine and its serial number.

Sine-Bar Fixture

Sine-Bar Fixture. Machy., vol. 25, no. 2, Oct. 1918, pp. 145-146, 4 figs. Drawings of fixture and explanation.

See also Machine Shop (Moving-Picture-Machine Making), (Hosiery-Machine Making).

MACHINERY, SPECIAL

Sand-Blast Machinery

Automatic Shell Cleaning Cabinet Sand-Blast. Can. Foundryman, vol. 11, no. 9, Oct. 1918, p. 265, 4 figs. Machine designed to provide continuous operation for cleaning 155-mm. shells with direct high pressure.

How to Select Suitable Sand-Blast Equipment, H. D. Gates. Foundry, vol. 46, no. 315, Nov. 1918, pp. 539-545, 12 figs. Results and operation costs should carry greater weight than first price; description of various types. Paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

MARINE ENGINEERING

Boat Lowering

Boat Lowering Appliances, J. R. Hodge. Tran. Inst. Marine Engrs., vol. 30, paper 237, Aug. 1918, pp. 123-127, 4 figs. and (discussion), pp. 127-136. Discusses merits of gear for lowering and disengaging of boats from vessels in emergencies at sea.

Boilers

Sediment in Marine Boilers, W. R. Austin. Steamship, vol. 30, no. 352, Oct. 1918, pp. 94-95, 1 fig. Points out where risk of accident generally arises.

Cargo Gear

Some Insufficiently Considered Details of Ship Construction and Equipment, C. Waldie Cairns. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 570-575. Analysis of conditions of yard management; details of ship equipment criticized; stresses on cargo gear. Paper before northeast Coast Inst. of Engrs. & Shipbuilders, Newcastle-upon-Tyne.

Concrete Ships

Concrete Barges Built True to Design Dimensions. Eng. News-Rec., vol. 81, no. 16, Oct. 17, 1918, pp. 704-707, 6 figs. Special spacer fix wall thickness and rod location; account of yard started at Providence, R. I.

Method of Building Concrete Barges at Yard of Aberthaw Construction Co. Eng. & Contracting, vol. 50, no. 17, Oct. 23, 1918, pp. 383-384, 3 figs. Description of work in progress at Fields Point, R. I. Also in Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 584-585, 3 figs.

Novel Method of Constructing Concrete Vessels, R. N. Stroyer. Shipbuilding & Shipping Rec., vol. 12, no. 14, Oct. 3, 1918, pp. 327-330, 5 figs. Description of writer's patented system which aims to reduce number of joints to minimum.

Standard Concrete Barge for Use on the New York State Barge Canal. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 586-588, 6 figs. Authorized design for service on state canal; unusual refinement of concrete used; plans and specifications.

The Building of Reinforced Concrete Ships. Engineering, vol. 106, no. 2744, Aug. 2, 1918, pp. 114-115, 4 figs. Illustrations taken at various stages of work showing reinforcing, etc.

Diving Machinery

Sisson Diving Machine. Steamship, vol. 30, no. 352, Oct. 1918, pp. 79-80, 2 figs. Oval shaped machine 9 ft. long, 7 ft. 6 in. in diameter, 9 tons weight, with pair of propellers on bottom for moving up and down and two on side for propelling forward or back.

Motorships

Motor Ship "Santa Margarita." Steamship, vol. 30, no. 352, Oct. 1918, pp. 91-92. Detail of ship equipped with Diesel Engines.

Propellers

Screw Propellers. Shipbuilding & Shipping Rec., vol. 12, no. 14, Oct. 3, 1918, pp. 331-332, 1 fig. Shape of blades and patent propellers; propeller immersion and efficiency. (Concluded.)

Rivetless Ships

See Welded Ships.

Salvage

Thirteen-Thousand-Ton Vessel Righted by Rolling and Lifting. Eng. News-Rec., vol. 81, no. 17, Oct. 24, 1918, pp. 764-767, 8 figs. Raising of "St. Paul" after settling on its side between New York piers.

Signaling

A Method of Avoiding Collision at Sea, J. Joly. Proc. Roy. Soc., vol. 94, no. A664, Aug. 1, 1918, pp. 547-560, 4 figs. Based on synchronized signals transmitted in different media, no other communication being necessary between the ships beyond signals.

Smoke System, Yarrow

The Yarrow Anti-Submarine Smoke System. Engineer, vol. 126, no. 3272, Sept. 13, 1918, pp. 218-219, 5 figs. Description of a smoke screen system of protection.

Standardized Ships

German Views on Standard Vessels, W. Kreul. Shipbuilding & Shipping Rec., vol. 12, no. 9, Aug. 29, 1918, pp. 212-213. Standardization as a means for accelerating building of ships; constructional parts and processes. Translated from Stahl und Eisen.

Standardized Concrete Ships in the United States. Shipbuilding & Shipping Rec., vol. 12, no. 9, Aug. 29, 1918, pp. 210-212. Alternative arrangement of concrete distributing plant.

Standardized Ships May be Permanent. Nautical Gaz., vol. 94, no. 17, Oct. 26, 1918, p. 224, 1 fig. Advantages and drawbacks of vessels of uniform type. From Engineering, London.

Stresses

Investigation of the Shearing Force and Bending Moment Acting on the Structure of a Ship, Including Dynamic Effects, A. M. Robb. Int. Mar. Eng., vol. 23, no. 10, Oct. 1918, pp. 592-593, 3 figs. Paper before Instn. of Naval Architects, London, March 1918.

Trimming Conveyor

Portable Automatic Trimming Conveyor. Colliery Guardian, vol. 96, no. 3012, Sept. 20, 1918, pp. 601-602, 6 figs. Description of an automatic conveyor used for trimming coal in bunkers on shipboard.

Valves, Kingston

Hand-Regulated Valves. Mech. World, vol. 64, no. 1650, Aug. 16, 1918, pp. 78-79, 7 figs. Kingston valves of ships as examples of construction where element of safety is predominant above other considerations. (Concluded from Aug. 2.)

Welded Ships

The British Welded-Steel Motorship. Motorship, vol. 3, no. 11, Nov. 1918, pp. 22-23, 5 figs. Method of operation of novel type of oil engine installed in a merchant vessel.

See also Factory Management (Shipbuilding Methods); Safety Engineering (Fire Protection); Corrosion (Electrolytic Prevention).

MATHEMATICS

Bessel Functions

The Addition Theorem of the Bessel Functions of Zero and Unit Orders, John R. Airey. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 234-242. Form of addition theorem of Jn (x) functions in which one of the terms is a root of a Bessel or Neumann function of zero or unit order.

A Diffraction Problem, and an Asymptotic Theorem in Bessel's Series, R. Hargreaves. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 191-199. Form to solve problem in two dimensions offered as more convenient than Sommerfeld's; also solution in definite integral transformed directly to series of Bessel's functions and trigonometrical functions of problem in three dimensions, which arises when plane of incident wave is not parallel to edge of barrier.

Collineation Groups

A Collineation Group Isomorphic with the Group of the Double Tangents of the Plane Quartic, C. C. Bramble. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 351-365. Derivation by mapping methods of collineation group in which variables are irrational invariants of quartic curve; system for group and associated canonical forms of quartic.

Differential Equations

On the Asymptotic Solution of the Non-Homogeneous Linear Differential Equation of the nth order. A Particular Solution, W. Van N. Garretson. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 341-350. Considers non-homogeneous equation where roots of characteristic equation are distinct, and follow, at the outset, the method employed by Dini in his researches on linear differential equations published in Annali di Matematica, ser. 3, vol. 2 (1898), pp. 297-324 and vol. 3 1899), pp. 125-183.

Fourier Theorem

Fourier's Theorem and the Trigonometric series (Sur le théorème de Fourier et les développements en series trogonométriques), G-A. Andrault. Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 331-340, 3 figs. Method of demonstrating synthetically and generalizing Fourier's theorem and study of the physical significance and independence of the coefficients.

History of Mathematics

Plans for a History of Methematics in the Nineteenth Century, Florian Cajori. Sci. vol. 48, no. 1238, Sept. 20, 1918, pp. 279-284, 2 figs. Determination of volume of mathematical literature to be penetrated. Before Am. Mathematical Soc.

Plane Algebraic Curves

On the Plane Algebraic Curves having Common Multiple Points (Sur les courbes algébriques planes ayant des points multiples communs), R. de Montessas de Ballore. Camptes Rendus des Séances de l'Académie de Sciences, vol. 167, no. 8, Aug. 19, 1918, pp. 290-293. Analytical investigation of contact of two curves of order n.

Pohlke's Theorem

Proof of Pohlke's Theorem and its Generalization by Affinity, Arnold Emch. Am. Jl. of Mathematics, vol. 40, no. 4, Oct. 1918, pp. 366-374, 3 figs. Proof of generalization and establishment of related propositions, by making use of affine collineations in space, of theorem: Three straight line segments of arbitrary length in a plane, drawn from a point and making arbitrary angles with each other, form a parallel projection of three equal segments drawn from the origin on three rectangular coördinate axes; however, only one of the segments, or one of the angles, can vanish.

Theta Modular Groups

Theta Modular Groups Determined by Point Sets, Arthur B. Cable. Am. Jl. of Methematics, vol. 40, no. 4, Oct. 1918, pp. 317-340. Establishes theorems concerning connection between point set and theta modular function in discontinuous groups defined by $\theta^2_{n,k}$

MECHANICS

Arches

Direct Design of Curvature of Arches, Frank Barber. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, pp. 379-381, 3 figs. Analytical method of finding ordinates of curve for concrete and masonry arches, with example.

Columns

Columns Subjected to Compression and Bending (Stänger, utsatta för tryck och böjning), A. Palmgvist. Teknisk Tidskrift, Väg och vatten Byggnadskonst, vol. 48, no. 9, 1918, pp. 137-142, 5 figs.

Motion, Dissipation of

The Law of Dissipation of Motion, Ernst Jonson. Am. Jl. of Sci., vol. 46, no. 274, Oct. 1918, pp. 578-580, 2 figs. Derivation of law by resolving motion resulting from collision of two particles into two perpendicular components in such a way that each component of one motion is parallel to one of components of other motion, and that the two components which have same direction have also same size.

Relativity, Principle of

The Principle of Relativity in Mechanics (Het relativiteitsbeginsel in de mechanica), G. J. Van de Well. De Ingenieur, year 33, no. 38, Sept. 21, 1918, pp. 736-747, 1 fig.

Shafts, Critical Velocity

A New Critical Velocity Occurring when the Bending of a Shaft is Accompanied by Vibrations (Eine neue kritische Wellengeschwindigkeit bei mit Biegung verbundenen Schwingungen), Gümbel. Dingler's polytechnisches Journal, vol. 333, no. 9, May 4, 1918, pp. 71-75, 2 figs.

A New Critical Velocity of Rotating Shafts (Eine neue kritische Wellengeschwindigkeit), A. Stodola. Dingler's polytechnisches Journal, vol. 333, nos. 1 and 3, Jan. 12 and Feb. 9, 1918, pp. 1-3, 1 fig., and pp. 17-19. (From Schweiz. Bauzeitung, Nov. 1917). An important article on the critical velocity of shafts containing interesting new views.

Critical Speeds of Shafts, G. Bonner. Mech. World, vol. 64, no. 1654, Sept. 13, 1918, pp. 128-129, 1 fig. Diagrammatic representation of torsion, thrust and centrifugal action stresses. Before N. E. Section Junior Instn. of Engrs. (To be continued.)

Torsional Stresses

Torsional Stresses, F. W. Salmon. Machy., vol. 25, no. 2, Oct. 1918, pp. 108. Table for finding torsional stresses for various sizes of shafts and of various sections.

See also Aeronautics (Stresses in Structure); Cement and Concrete (Sections); Internal-Combustion Engineering (Governors).

METAL ORES

Chromium

Chromite, J. C. Williams. Min. & Eng. Rec., vol. 23, nos. 15 and 16, Aug. 31, 1918, pp. 160-162. Foreign deposits, ore in United States; uses; alloys; description; occurrence; concentration; and recognition of this mineral.

Iron

The Occurrence of Iron Ores in East Netherlands (Het voorkomen van ijzeretsen in Oost-Nederland), W. H. D. de Iongh. De Ingenieur, year 33, no. 34, Aug. 24, 1918, pp. 644-648, 2 figs.

Talc

Talc: Its Occurrences and Uses, Percy A. Wagner. Min. Mag., vol. 19, no. 4, Oct. 1918, pp. 218-220. Occurrences in South Africa and information as to uses throughout the world. From South African Jl. of Ind.

Tungsten

The Genesis of Tungsten Ores, R. H. Rastall. Min. Jl., vol. 123, no. 4338, Oct. 12, 1918, pp. 597-598. Sheelite deposits; secondary tungsten deposits. From Geological Mag. (Continuation of serial.)

METAL-WORKING TOOLS

Boring Machines

Cylinder Boring Machine. Can. Machy., vol. 20, No. 17, Oct. 24, 1918, p. 485, 1 fig. Although specially designed for boring cylinders of Liberty motors, the machine can, by slight changes in design of gearing, etc., be made to accommodate most boring operations.

Gidding and Lewis No. 4, Boring, Milling and Drilling Machine. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 777-778, 1 fig. Principal dimensions and general description.

Centering Machine

Machine for Accurately Centering Shells. Can. Machy., vol. 22, no. 16, Oct. 17, 1918, p. 455, 1 fig. System followed by Modern Tool Mfg. Co.

Chisels

The Cold Chisel, J. A. Lucas. Coal Age, vol. 14, no. 16, Oct. 17, 1918, pp. 730-734, 27 figs. Various types of cold chisels and their uses.

Lathes

Massive Shell Lathes for Neville Island. Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1071-1074, 5 figs. Machine for boring and turning shells 12 in. in diameter and larger and features developed especially for operations in view.

Simplified Lathe Adapted to Shell Work. Iron Age, vol. 102, no. 16, Oct. 17, 1918, pp. 945-948, 13 figs. Description of 16- and 25-in. simplified Gisholt lathes.

Locomotive Repair Tools

Repairing Locomotive Fittings, Frank A. Stanley. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 663-665, 8 figs. Description of tools used in Californian railway repair shop.

METALLURGY

Brass

Thermal Expansion of Alpha and of Beta Brass between 0-600 Deg. Cent., P. D. Merica and L. W. Schad. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, p. 511. Comparison of thermal expansions of two constituents, alpha and beta, of which 60:40 brass is composed. (Abstract.)

Bronze, Phosphorus Content

Estimating Phosphorus in Bronzes, R. E. Rooney. Practical Engr., vol. 58, no. 1648, Sept. 26, 1918, p. 153. Table showing results obtained with different samples of commercial bronze by rapid and gravimetric methods of analysis.

Copper

Pure Carbon-Free Manganese and Manganese Copper, Arthur F. Braid. Bul. Am. Inst. Min. Engrs., no. 143, Nov. 1918, pp. 1697-1698. Deoxidizers and their uses in copper alloys.

Flue Gases

Precipitation from Flue Gases. Elec. Rev., vol. 73, no. 15, Oct. 12, 1918, p. 575, 2 figs. Description of installation at copper refinery where copper particles are recovered by the Cottrell process.

Grain Growth

Grain Growth in Metals, Zay Jeffries. Practical Engr., vol. 58, no. 1648, Sept. 26, 1918, pp. 151-153. Definition of germinative temperature; general laws of grain growth; typical examples. (Continuation of serial.)

Hardness of Metals

Hardness and Hardening, T. Turner. Metal Ind., vol. 16, no. 10, Oct. 1918, pp. 460-464, 1 fig. Address before British Inst. of Metals, Sept. 1918.

See also Engineering Materials (Copper), (Gun Metal).

MILITARY ENGINEERING

Ambulance Trains

An Ambulance Train for the American Army. Engineer, vol. 126, no. 3274, Oct. 27, 1918, pp. 260-262, 15 figs. Drawings and description of the British-built American ambulance train for American army.

Artillery

On the Propagation of Sound of a Cannon at a Great Distance (Sur la propagation du son du canon à grande distance), Maurice Collignon. Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 333-335. Table of results of experimental work.

Variation of the Sight Position in Firing at Different Angles of Elevaton (Aenderung

der Visierstellung beim Schiessen unter verschiedenen Geländewinkeln), K. Michalke. Dingler's polytechnisches Journal, vol. 333, no. 10, May 18, 1918, pp. 82-84, 5 figs.

Explosives

Digging Pole Holes with Dynamite, C. R. Van Druff. Telephony, vol. 75, no. 18, Nov. 2, 1918, pp. 36-38, 4 figs. Method of blasting holes with dynamite to produce satisfactory results in different kinds of soil.

Sengite: The New South African Explosive, J. P. Udal. Min. Mag., vol. 19, no. 4. Oct. 1918, pp. 215-216. Gun-cotton base explosive, made by same process as tonite but substituting nitrate of soda for nitrate of barium. From South American Jl. of Ind.

Supply Base

Army Supply Base, South Brooklyn, N. Y. Contracting, vol. 7, no. 9, Nov. 1, 1918, p. 279. Placing of more than 11,000 yd. of floor and roof concrete.

See also Chemical Technology (Ammonia); Chemical Technology (Explosives); Safety Engineering (Explosives).

MINES AND MINING

Drills

Diamond-Drilling in Cornwall, J. A. MacVicar. Min. Mag., vol. 19, no. 4, Oct. 1918, pp. 184-187. Work done with Sullivan diamond-drill and author's opinion as to future possibilities.

Improved Sharpener Dies Make Better Drill Bits, Howard T. Walsh. Alaska & Northwest Min. Jl., vol. 12, no. 10, Oct. 1918, p. 91, 3 figs. Chart showing results obtained by one of largest copper mines in United States.

Efficiency

Increasing Coal Mine Efficiency, Charles E. Stuart. Coal Age, vol. 14, no. 16, Oct. 17, 1918, pp. 724-727, 5 figs. First of a series of articles on mine efficiency.

Engineers

The Work of the Mining Engineer, R. S. McCaffrey. Wisconsin Engr., vol. 22, no. 7, April 1918, pp. 285-286. Requirements of mining geology, mine engineering, and metallurgy.

Mine Gases

The Limits of Complete Inflammability of Mixtures of Mine Gases and of Industrial Gases with Air, Geo. A. Burrell and Alfred W. Ganger. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, p. 236, 2 figs. Results of experiments. From Tech. Paper 150, Bureau of Mines, Dept. of Interior.

Oil Shales

A Possible Fuel Oil Industry for Canada, James Ashworth. Can. Min. Jl., vol. 39, no. 19, Oct. 1, 1918, pp. 330-331. Discusses possibilities of encouraging production of oil and other by-products from coal and oil shales.

Ventilation

Canvas Tubing for Mine Ventilation, Lester D. Frink. S. A. Min. Jl., vol. 27, part 2, no. 1406, Sept. 7, 1918, p. 421. Explains manner in which canvas tubing is being used in the North Butte Co.'s mines at Butte, Mont. (To be continued.)

Water in Mines

The Unwatering of the Pensford Colliery, Charles Lewis. Iron & Coal Trades Rev., vol. 97, no. 2640, Oct. 4, 1918, pp. 371-374, 6 figs. Before South Wales Branch of Assn. of Min. Elec. Engrs., Sept., 1918.

See also Electrical Engineering (Induction Motors); Safety Engineering (Mine Rescue).

MOTOR-CAR ENGINEERING

Alcohol

The Utilization of Alcohol and Mixtures of Alcohol with Hydrocarbons, such as Benzole instead of Gasoline in Motor Cars, D. Tagneyeff (in Russian). Proc. of Russian Technical Soc., year 1917, nos. 4-7, Apr.-July, pp. 51-57, 1 fig. Data of work carried out by various German engineers.

Crane Tractor

An Electric Crane Tractor. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 399-400, 1 fig. Machine with 15-ton trailing load capacity and provided with removable battery compartment.

Engines

Dorris Two-Ton Truck Model K-4. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 508-509, 4 figs. Detachable cylinder head doing away with valve cages.

Steam Motors

A New Coke Fuel Steam Motor. Engineer, vol. 126, no. 3266, Aug. 2, 1918, pp. 101-103, 11 figs. Details of coke fuel boiler and steam engine used in new steam automobile.

Tires

Tires for Tractor and Similar Vehicle Wheels. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, p. 6, 4 figs. Invention said to enable any existing tractor wheel of any diameter to be readily fitted with a number of studs or projections which will improve grip of wheel.

Tractors

The Wolverine Tractor. Auto, vol. 23, no. 40, Oct. 4, 1918, pp. 733-735, 7 figs. General features of 2-ton 30-50 hp. for three-furrow plowing.

Transmission

The Nuttall Traction Transmission. Automotive Ind., vol. 39, no. 12, Sept. 19, 1918, pp. 506-507, 4 figs. Designed to give two forward speeds and reverse and adaptable to either a longitudinally or a transversely mounted engine.

See also Hoisting and Conveying (Tractor-Trailer); Transportation; Electrical Engineering (Magneto), (Storage Batteries); Internal-Combustion Engineering; Roads and Pavements (Motorized Equipment).

MUNICIPAL

Poles

Joint Usage of Poles—A War Economy, T. N. Bradshaw. Elec. World, vol. 72, no. 18, Nov. 2, 1918, pp. 840-841, 1 fig. Statement of civic, economic and safety advantages resulting from adoption of practice; opinions regarding the form of construction which should be employed. Paper before International Assn. of Municipal Electricians, Atlanta, Sept. 1918, by A. L. Pierce.

Sanitary Survey

A Sanitary Survey of a City. Mun. Jl., vol. 45, no. 19, Nov. 9, 1918, pp. 359-361, 3 figs. Account of survey made by a State board of health. (To be concluded.)

Street Cleaning

A Report on Street Cleaning. Good Roads, vol. 16, no. 17, Oct. 26, 1918, pp. 160-161. Text of report submitted to Am. Soc. of Mun. Improvements by its committee on street cleaning.

Motor Apparatus in Buffalo Street Department, W. F. Schwartz. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 317-318, 1 fig. Sweepers and flushers. Before Am. Soc. Mun. Improvements.

Street Cleaning in San Francisco, Chas. W. Geiger. Mun Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 315-317, 7 figs. Downtown streets swept by day and flushed by night; districting and increasing efficiency of force.

Surveying

Problems in City Surveying, W. W. Perrie. Can. Engr., vol. 35, no. 12, Sept. 19, 1918, pp. 257-260, 3 figs. and (discussion), pp. 260-261, 1 fig. Classification and description of resurveys. Before Assn. of Ontario Land Surveyors.

See also Lighting (Street Lighting); Sanitary Engineering.

MUNITIONS

Ammonia

Why We Are Asked to Conserve Ammonia, W. F. Sutherland. Power House, vol. 11, no. 10, Oct. 1918, pp. 290-291. Importance of ammonia in modern warfare.

Chucks

Chuck for Three-Inch Shrapnel Shells, Donald A. Baker. Machy., vol. 25, no. 2, Oct. 1918, pp. 111, 3 figs. Decribes and gives drawings of chuck.

Explosives

Military Explosives of Today (III.), J. Young. Jl. Roy. Soc. of Arts, vol. 66, no. 3439, Oct. 18, 1918, pp. 733-742, 4 figs. Requirements and classification of high explosives for shell filling; methods of detonation; tests for explosives; rate of detonation.

Fuses

Making the Mark III Detonating Fuse, Edward K. Hammond. Machy., vol. 25, no. 2, Oct. 1918, pp. 137-144, 13 figs. (Second article.)

Guns

The Development of Gun Manufacture, W. H. W. Skerrett. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 655-661, 9 figs. Reviews construction and manufacture of guns from earliest times up to present high-pressure methods.

Shell Assembling Die

Shell Base-Cover Assembling Die and Press, P. H. White. Machy., vol. 25, no. 2, Oct. 1918, pp. 109, 5 figs. Describing a die and press developed by Root-Van Dervoort Engineering Co. of East Moline, Ill.

Shells

Cast-Iron Shells in Permanent Moulds, Edgar A. Custer. Foundry Trade Jl., vol. 20, no. 201, Sept. 1918, pp. 471-473, 2 figs. Essentials in their manufacture and data on a 1100-lb. casting.

High Explosive Shells and Shrapnel, J. M. Hall. Iron & Steel Inst. of Can., vol. 1, no. 8, Sept. 1918, pp. 333-338, 4 figs. Outline of general practice as used by one of largest producers. Before Steel Treating Research Soc.

Machining and Gaging 9.2-inch High-Explosive Howitzer Shells, M. H. Potter. Machy., vol. 25, no. 2, Oct. 1918, pp. 125-132, 17 figs. Machines and tools used, successive order of machining operations, and complete gaging equipment.

Making Semi-Steel Projectiles, Iron Age, vol. 102, no. 15, Oct. 10, 1918, pp. 879-883, 22 figs. Method of molding, including core making, and machining as practiced by American Radiator Co., at Buffalo.

The British 6-in. Howitzer, I. W. Chubb, Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 697-704, 24 figs. Breech mechanism. (Fourth article.)

Small Arms

Revolvers and Automatic Pistols (Les revolvers et les pistolets automatiques), L. Cabanes. Génie Civil, vol. 73, no. 6, Aug. 10, 1918, pp. 110-113, 12 figs. Mauser, 1912 model; parabellum; Mannlicker, 1900. Continuation of serial.)

Stokes Gun

The Stokes Bomb-Throwing Gun (II), Wilfred Stokes. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, pp. 228-230, 14 figs. Details of projectile and of propellant; range; time fuse; percussion fuse. (Concluded.) Also in Sci. Am. Supp., vol. 86, no. 2231, Oct. 5, 1918, pp. 212-213, 10 figs.

See also Metal-Working Tools (Lathes); Forging (Shell Forging); Testing and Measurements (Shell Steel).

PAINTS AND FINISHES

Oil, Infected

Paint Disease, James Scott. Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 198-199, 3 figs. Experimental confirmation of author's previous statement in regard to destructive effect of infected oil.

PHYSICS

Acoustics

Note on the Theory of the Double Resonator, Lord Rayleigh. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 231-234. Direct mathematical consideration of the general case of a double resonator where two reservoirs of different volumes communicate with each other and with the atmosphere by narrow passages. This case cannot be treated by formula given in author's Theory of Sound.

Adsorption of Gases

The Adsorption of Gases on Plane Surfaces of Glass, Mica and Platinum, Irving Langmuir. Jl. Am. Chem. Soc., vol. 40, no. 9, Sept. 1918, pp. 1361-1403. Experimental confirmation of author's theory of adsorption—that it is the result of time lag between condensation of gas molecule impinging on solid and its subsequent evaporation—against results obtained by other investigators who claim that adsorbed films are relatively thick.

Aggregation

A Geometrical Basis for Physical and Organic Phenomena, John Millis. Science, vol. 48, no. 1241, Oct. 11, 1918, pp. 353-360, 1 fig. Geometrical analysis of principle stated in previous paper by writer: In any aggregation of an indefinite number of equal spherical bodies an arrangement giving minimum total volume occupied and perfect symmetry is impossible.

Air

Physics of the Air, W. J. Humphreys. Jl. Franklin Inst., vol. 186, no. 4, Oct. 1918, pp. 481-510, 3 figs. Types and latitude variation of aurora polaris; gradient wind velocity tables for every 5 deg. of latitude from 25 to 60 deg. (Concluded.)

Arc, Circular

Some Two-Dimensional Potential Problems Connected with the Circular Arc, W. G. Bickley. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 273-279, 6 figs. Drawings of stream lines in case of disturbance due to infinitely long lamina in the form

of circular arc, examination of case of rotation of the arc, and brief discussion of motion of arc when free to move and acted upon by the consequent fluid pressures.

Arc, Electric, in Gases

Experimental Examination of the Arc in Gases under Pressure, W. Mathiesen. Elecn., vol. 81, no. 2106, Sept. 27, 1918, pp. 451-452, 2 figs. Abstract of article in Elektrotechnische Zeitschrift, no. 49, 1917.

Crystals

New Method of Analysis of Crystals by Means of X-Rays (Nouvelle méthode d'analyse des cristaux au moyen des rayons X). Revue Générale des Sciences, year 29, nos. 15-16, Aug. 15-30, 1918, pp. 449-450. Method consists of photographing diffraction image obtained by passing narrow pencil of monochromatic X-rays through an ensemble of small crystals of substance.

Evaporation

The Evaporation of Small Spheres, Irving Langmuir. Phys. Rev., vol. 12, no. 5, Nov. 1918, pp. 368-370. Suggests theoretical explanation for phenomena observed in experiments on evaporation of small iodine spheres of about one millimeter diameter performed by Harry W. Morse and described in Proc. Amer. Acad. Arts & Sci., vol. 45, Apr. 1910.

Heat

Is the Principle of Equivalence a Consequence of Carnot's Principle? (Le principe de l'équivalence est-il une consequence du principe deCornot?), C. Raveau. Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 9, Aug. 26, 1918, pp. 329-331. On the nature of heat as directly deductible from the postulate of Carnot.

Optics

An Optical Method for Accurately Dividing a Circle into Degrees, R. S. Clay. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 188-189, 5 figs. Based on symmetrical images by two inclined mirrors. From Trans. Optical Soc., London.

The Scattering of Light by Air Molecules, R. W. Wood. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 272-273. Result of experiments indicating that ultra-violet light causes precipitation of something from air, causing a slight cloud.

State, Equation of

On the Influence of the Finite Volume of Molecules on the Equation of State, Megh Nad Shaha and Satyendra Nath Basu. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 199-202. Argument to show that b in van der Waal's equation of state, taking into account finiteness of molecules and influences of forces of cohesion, does not properly represent influence of finite molecular volumes.

Vibrations

Forced Vibrations Experimentally Illustrated, E. H. Barton and H. M. Browning. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 212, Aug. 1918, pp. 169-178, 2 figs. Types of experiments illustrating qualitatively and quantitatively the chief phenomena concerned with forced vibrations similar to the ones occurring in resonance tubes, fluorescence, Lodge's syntonic jars, Hertz's oscillator and resonator, and wireless telegraphy; detailed theory explaining them.

On Kirchhoff's Formulation of the Principle of Huygens, A. Anderson. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 261-270, 3 figs. Deviation in usual procedure to establish Kirchhoff's formula consisting in beginning with a single source and assuming that the vibrational velocity at a distance r from source of disturbance is $(M/r)\ \Phi\ (t-\frac{r}{a})$, where M is a constant and a the velocity of propagation.

PIPE

Joints

Cement Joints for Gas Mains. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 21-23, 3 figs. Suggestions regarding design of cement joints made from experimental tests conducted at Iowa State college, Ames, and Highland Park College, Des Moines. Abstract of article in Iowa Engr., Apr. 1918.

Sewer Pipe

How Glazed Cement Sewer Pipe is Made. Cement & Eng. News, vol. 30, no. 8, Aug. 1918, p. 22. Description of Process followed by a Cal. manufacturing concern.

Winter Breakages

Methods for Obviating Pipe Breakages in Winter (Beseitigung der Gefahr von Rohrbrüchen bei Frostwetter), Lorenz. Journal für Gasbeleuchtung, year 61, no. 20, May 18, 1918, pp. 236-237.

POWER GENERATION AND SELECTION

Agriculture

Note on the Applications of Electricity to Agriculture (sur les applications de l'électricité a l'agriculture). Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 352-354. Conditions under which a central station for rural power consumption can be installed.

Costs

Mastering Power Production, Walter N. Polakov. Indus. Management, vol. 56, no. 4, Oct. 1918, pp. 321-329, 6 figs. Principle of essential cost and use of standard cost. (Ninth article.)

Docks

Utilization of Electricity in Docks and Harbors. Shipbuilding & Shipping Rec., vol. 12, no. 9, Aug. 29, 1918, pp. 205-206. Review of possibilities opened up by recommendations of Coal Conservation Committee recently issued by Ministry of Reconstruction.

Dredging

Using Electric Power to Dredge a Relocated River Channel, J. H. Walter. Eng. News-Rec., vol. 81, no. 16, Oct. 17, 1918, pp. 723-725. Washington Counties build suction dredge operated by 800-horsepower motor.

Isolated Plant

Interconnection Will Help Coal Situation. Power House, vol. 11, no. 10, Oct. 1918, pp. 294-296. Considerations on practicability of interconnecting isolated plants with central station.

Quarry

The New Modern Rock Crushing Plant of the Brownell Improvement Company. Cement Eng. News, vol. 36, no. 8, Aug. 1918, pp. 38-39, 1 fig. Quarry operations and details of power plant and electrical features.

Rolling Mills

Electrification of a Steam-Driven Three-High Merchant Mill at the Frodingham Iron and Steel Works. Elecn., vol. 81, no. 2098, Aug. 2, 1918, pp. 297-299, 4 figs. Account of some problems which were solved in making change from steam to electricity.

Statistics of Consumption

Power Consumption of National Industries, L. W. Schmidt. Power, vol. 48, no. 18, Oct. 29, 1918, pp. 628-630. An attempt by author to evolve a scheme according to which power requirements of leading national industries should be measured with a view to facilitating regional distribution and to prevent waste; a statistical table accompanies article.

Waste Heat

The Utilization of Waste Heat from Open-Hearth Furnaces for the Generation of Steam, Thomas B. Mackenzie. Iron & Steel Inst., advance copy, paper 12, Sept. 12-13, 1918, 24 pp., 4 figs. Report of tests conducted by author with acid-lined open-hearth furnace of 30 tons nominal capacity and Babcock and Wilcox water-tube boiler having 720 sq. ft. heating surface.

Water Power

Power Possibilities in California, F. H. Fowler. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 393-395, 2 figs. Survey of streams indicating where maximum development has already been reached, drawbacks of certain localities and advantages of others.

The Energy Supply of North America, C. P. Steinmetz. Elec. News, vol. 27, no. 20, Oct. 15 1918, pp. 22-24 and 38. Urges conservation of coal and utilization of all possible water powers. Before Am. Inst. Elec. Engrs.

See also Air Machinery (Wind Power); Hydraulic Engineering (Inter-connected Plants).

POWER PLANTS

Argentine

Power Supply for the Central Argentine Electrification. Elec. Ry. Jl., vol. 52, no. 15, Oct. 12, 1918, pp. 646-650, 3 figs. Description of steam turbine electric power station supplying traction, lighting and power requirements in suburbs of Buenos Aires. Also in Elec. World, vol. 72, no. 15, Oct. 12, 1918, pp. 684-687, 3 figs.

Boiler-Room Management

See Operation.

Boiler Settings

Tight Boiler Settings an Aid to Economy, J. E. McCormack. Power House, vol. 11, no. 10, Oct. 1918, pp. 292-293. Instances under author's observation and suggestions to secure air-tightness.

Costs

Plant Arrangement and Costs of Construction. Elec. World, vol. 72, no. 17, Oct. 26, 1918, pp. 780-782, 4 figs. Features of latest station of Turners Falls Power & Electric Company, Chicopee Junction, Mass. (First article.)

Engine Economy

Increasing Engine Economy, M. A. Saller. Power Plant Eng., vol. 22, no. 21, Nov. 1, 1918, pp. 870-873, 7 figs. Effects on capacity and efficiency of running engine condensing. (Fourth article.)

Floods

The Power Station at Millers Ford. Elec. Rev., vol. 73, no. 16, Oct. 19, 1918, pp. 603-608, 7 figs. Description of features of new steam-electric power plant of Dayton Power Light Co. Precautions against floods.

Hydroelectric

Fourth Successive Hydro-Electric Plant Nears Completion at Rumford, Maine. Eng. News-Rec., vol. 81, no. 15, Oct. 10, 1918, pp. 654-657, 6 figs. Development, begun in 1892, has increased from 200 to 30,000 hp. Description with map and sketches of the new work.

Malamort Electric Power House (L'usine électrique de Malamort), A. Boudrau. Revue Générale de l'Electricité, year 29, nos. 15-16, Aug. 24, 1918, pp. 270-274, 6 figs. Account of development of hydroelectric power station.

New Hydroelectric Plant of Montana Power Company, W. A. Scott. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, pp. 535-537, 2 figs. (Second article.)

Instruments

See Operation.

Operation

Arrangements to Avoid Operating Difficulties. Elec. World, vol. 72, no. 16, Oct. 19, 1918, pp. 732-734, 8 figs. Description of a plant in Dayton, Ohio, in which special attention has been given to handling coal economically, obtaining clean intake water, providing flexible piping layout and furnishing adequate boiler-room instruments.

Boiler-Room Management Plan, T. N. Wynee. Elec. World vol. 72, no. 12, Sept. 21, 1918, pp. 549-552, 5 figs. How fifty to one hundred thousand dollars is saved annually by Indianapolis Company in trained boiler-room men and in adequate boiler-room equipment. From paper before Indiana Electric Light Assn., Aug. 1918.

Power Plant Management; The Use of Instruments, Robert June. Power House, vol. 11, no. 10, Oct. 1918, pp. 281-283, 7 figs. Summary of best current practice.

The Millers Ford Station. Power Plant Eng., vol. 22, no. 20, Oct. 15, 1918, pp. 825-831, 10 figs. Unique method of handling condenser water, flood protection; electrical layout; description of steam-electric plant at Dayton, O.

Waterworks Operation. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 322-324. Using records for increasing efficiency; analyzing flue gases; soot blowers; steam jets; chain grate, overfeed and underfeed stokers.

Power Factor

Getting the Maximum Out of Equipment, Will Brown. Elec. World, vol. 72, no. 17, Oct. 26, 1918, pp. 791-793, 1 fig. The power producer and the user must coöperate in order to improve power factor, otherwise adequate power to meet essential needs may not be available in approaching winter; remedy readily applicable.

Power-Factor Correction, an Urgent Necessity, Will Brown. Elec. World, vol. 72, no. 18, Nov. 2, 1918, pp. 834-837, 1 fig. Overlapping of fall lighting and power loads together with fuel scarcity may curtail power unless power factor is improved; causes of low power factor, how to locate them and the proper remedies to apply.

Soot in Boiler Tubes

Keeping Boiler Tubes Free from Soot, W. Saller. Power House, vol. 11, no. 10, Oct. 1918, p. 297. Effect of soot accumulation on boiler efficiency.

Turbo-Electric

A New 25,000-kw. Power Plant for Dayton, Ohio. Power, vol. 48, no. 18, Oct. 29, 1918, pp. 620-624, 3 figs. Principal data and description of new turbo-electric plant.

Detailed Description of Recently Installed 45,000-kw. Turbine Generators, J. P. Rigsby. Elec. News, vol. 27, no. 20, Oct. 15, 1918, pp. 28-30. Westinghouse cross-compound, double-unit type, consisting of a high and low pressure turbine, each connected through a flexible coupling to its own generator, mounted on separate bedplates supported on foundations lying parallel to each other.

Water Softening

Use of Soda Ash in Water Softening, William Henry Hobbs. Ry. Rev., vol. 63, no. 18, Nov. 2, 1918, pp. 633-635. Emphasizes im-

portance of accuracy in adjusting treatment to individual needs.

See also Air Machinery (Air Supply to Boiler Room); Building and Construction (Wind Pressure), (Chimneys); Engineering Materials (Boiler Plates); Corrosion (Electrolytic Prevention).

POWER TRANSMISSION

Belting

Textile Belting for Driving and Conveying, A. Chadwick. India-Rubber Jl., vol. 56, no. 14, Oct. 5, 1918, pp. 1-5, 4 figs. Manufacture of sewn cotton ducks, balata, solid woven cotton, and solid woven hair belting. Before Lancashire Section of Textile Industry.

Magnetic Gearing

Magnetic Gearing Arrangement (fuelques dispositifs d'embrayage magnétique). Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 354-356, 5 figs. Principle of operation and scheme of connections of an automatic differential type.

PRODUCER GAS AND GAS PRODUCERS

Wood Gasification

Some Data of Tests on Wood Gasification in Inclined Retorts in Sweden (Einige Mitteilungen über Versuche mit Holzvergasung in geneigten Retorten bei Vårtagasverket in Stockholm, Schweden), Adolf Molin. Journal für Gasbeleuchtung, year 61, no. 5, Feb. 2, 1918, pp. 50-55, 5 figs.

PUMPS

Centrifugal

Progress in Water Works Pumping Machinery, L. D. Grisbaum. Fire & Water Eng., vol. 64, no. 12, Sept. 18, 1918, pp. 202-203. Development of centrifugal pumps and their various present uses.

Irrigation

Operating Features of a California Pumping Project. Elec. Rev., vol. 73, no. 14, Oct. 5, 1918, pp. 523-525, 4 figs. Terra Bella irrigation system operated entirely by motor-driven pumps supplied by central station.

See also Steam Engineering (Pumping Engines).

RAILROAD ENGINEERING, ELECTRIC

Electrification

Railway Electrification to Save Fuel, W. J. Davis. Jl. of Elec., vol. 41, no. 9, Nov. 1, 1918, pp. 411-412. Figures bringing out loss of fuel which results from present method of making each engine a power plant in itself.

Power House

Electrification of the Central Argentine Railway. Power, vol. 48, no. 16, Oct. 15, 1918, pp. 550-554, 5 figs. Details of power house and equipment.

Rolling Stock

Efficient and Systematic Maintenance Prolongs Life of Rolling Stock and Reduces Operating Costs. Elec. Ry. Jl., vol. 52, no. 14, Oct. 5, 1918, pp. 622-623, 5 figs. Account of methods of Evanston, Ill., Railway in cutting power costs and increasing fare collections.

Heavy Electric Traction on the Central Argentine. Elec. Ry. Jl., vol. 52, no. 14, Oct. 5, 1918, pp. 604-609, 7 figs. Details of rolling stock, power and brake control, collecting shoe and conducting rail.

Suburban Lines

Electric Railways in Argentina. Times Eng. Supp., no. 528, Oct. 1918, pp. 208-209, 3 figs. Details of transmission and distribution in Central Argentine suburban lines.

Track Switches, Automatic

Automatic Track Switches Release Men for Other Work, R. C. Cram. Elec. Ry. Jl., vol. 52, no. 16, Oct. 19, 1918, pp. 686-693, 18 figs. Study of development and present status of automatic and remote-control track switches with consideration of factors which have contributed to their evolution.

Universal Cars

The First Universal Car. Elec. Ry. Jl., vol. 52, no. 17, Oct. 26, 1918, pp. 729-730, 1 fig. Preliminary details of one-man, two-man pre-payment and post-payment car submitted by War Board to Housing Bureau.

See also Machine Shop (Gear Cutting).

RAILROAD ENGINEERING, STEAM

Alaska

Railroad Construction Progress in Alaska. Ry. Rev., vol. 63, nos. 14 and 15, Oct. 5 and 12, 1918, pp. 487-490, 7 figs and 537-539, 7 figs. Line between Seward and Anchorage completed; work on other sections well advanced.

Boilers

Constructing Locomotive Boilers and Fireboxes. Ry. Gaz., vol. 29, no. 12, Sept. 20, 1918, pp. 311-312, 2 figs. Operation of portable gap riveter.

Brazil

The Development of the Brazilian Railways. Ry. Age, vol. 65, no. 16, Oct. 18, 1918, pp. 701-704, 4 figs. Statistics of Brazilian railways; Brazil presented as important potential market for American railway supply manufacturers; statistics of imports of railway equipment.

Brakes

Importance of High-Speed Brakes in Railroad Operation (l'importance des freins rapides dans l'exploitation des chemins de fer), J. Cablier. Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, pp. 351-352. Comparison of interest and amortization of involved expense with benefit derived in transportation service.

Cars

U. S. R. A. Standard Baggage Cars. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 561-564, 6 figs. Description of 60-ft. and 70-ft. all steel baggage cars constructed for U. S. Railroad Administration.

Draft Gears

Draft Gears Should Be Maintained, L. T. Canfield. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 565-567, 2 figs. Proper protection to car and to lading requires a system of periodical inspection and repairs.

Fireboxes

The Belpaire Firebox. Ry. Gaz., vol. 29, no. 12, Sept. 20, 1918, p. 308, 3 figs. Account of American experience with that type and subsequent design modifications required.

French Equipment

See Operation.

Heating, Train

The Coal Saving Problem and Train Heating. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, pp. 383-384, 2 figs. Suggests apparatus for recovering waste heat. Before Instn. Locomotive Engrs.

Loading

Proper Methods of Loading Automobiles. Ry. Rev., vol. 63, no. 16, Oct. 19, 1918, pp. 565-569, 11 figs. Analysis of methods employed by shippers and a representative railroad.

Locomotive Crankpin

A Ball Bearing Crank Pin. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, p. 385, 2 figs. Application of ball-bearing to crank pin of a 2-10-2 type. From Ry. Mech. Engr.

Locomotive Firing

The Economical Use of Coal in Railway Locomotives. University of Ill. Bul., vol. 16, no. 2, Sept. 9, 1918, 71 pp., 17 figs. Statement of facts concerning choice, distribution, storage, and use of coal, and suggestions intended to supplement efforts of railway men to save coal.

Locomotive Valve Gear

A New Locomotive Valve Gear. Ry. Gaz., vol. 29, no. 14, Oct. 4, 1918, p. 359, 1 fig. Motion of valve same as obtained with Stephenson gear, but eccentric motion work removed from between frames and applied to outside using double crank arm as substitute for eccentrics and straps.

Locomotives

First Standard 0-8-0 Switcher. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 543-545, 5 figs. Description and principal data of standard switcher built for U. S. Railroad Administration. Also in Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 513-515, 4 figs.

4-6-0 Passenger and Double Bogie Tender, London & South-Western Railway. Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 184-186, 2 figs. Dimensions of cylinders, wheels, valve gear, boiler, heating surface, and weights. Also in Ry. Gaz., vol. 29, no. 14, Oct. 4, 1918, p. 361, 1 fig.

4-6-2 Type Locomotive, Philadelphia & Reading Railway. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, p. 387, 1 fig. Features and dimensions.

Heavy Mallet Compound for Virginian Railway. Ry. Rev., vols. 63 and 65, nos. 14 and 16, Oct. 5 and 18, 1918, pp. 497-498 and 688-691, 3 figs. General description with principal data.

Modern Locomotive Engine Design and Construction (XLII). Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 187-191, 4 figs. Effect of superheating on both steam and fuel consumption at various rates of expansion.

Pacific Type Locomotives for the Central of New Jersey. Ry. Age, vol. 65, no. 18, Nov. 1, 1918, pp. 769-770, 1 fig. Description and principal data.

U. S. R. A. Standard Six-Wheel Switching Locomotive. Ry. Age, vol. 65, no. 15, Oct. 11, 1918, pp. 655-657, 3 figs. Principal data, drawings and tonnage chart, with general description of smallest government engines.

Long Fork Railroad

The B. & O. Completes the Long Fork Railway, A. C. Clark. Ry. Age, vol. 65, no. 15, Oct. 11, 1918, pp. 663-665, 5 figs. Description of new line which is important step in development of coal resources of Kentucky.

Operation

Difficulties in Handling French Equipment, J. N. McVey. Ry. Rev., vol. 63, no. 16, Oct. 19, 1918, pp. 581-584. Trials encountered by Amer. Ry. Engrs. in handling foreign equipment.

Permanent Way

Stresses in Permanent Way. Ry. Engr., vol. 39, no. 465, Oct. 1918, pp. 191-194, 8 figs. Report of extensive tests made on two lines in United States, on various sections. (Continuation of serial.)

Rails

A Metallographic Investigation of Transverse-Fissure Rails with Special Reference to High-Phosphorus Streaks, G. F. Comstock. Bul. Am. Inst. Min. Engrs., no. 143, Nov. 1918, pp. 1699-1714, 17 figs. Experimental research of two proposed theories regarding formation of fissures: (1) that they are the result of fatigue of steel, and (2) that they are originated from a defect on steel.

Common Defects in Rail. Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 498-501. From paper by C. W. Gennet before convention of Roadmasters & Maintenance of Way Assn., Chicago, Sept. 1918.

Relative Life of Manganese and Open-Hearth Rail on Curves, H. W. Roberts. Elec. Ry. Jl., vol. 52, no. 16, Oct. 19, 1918, pp. 697. Results of tests are given showing manganese rail to wear about seven times as long as open hearth.

Why Busy Rails Do Not Rust, Oliver P. Watts. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 359-361. Review of experimental investigations by various authors. Before Am. Elec. Chem. Soc.

Rates

Railway Rates, R. A. Lehfeldt. Jl. S. A. Instn. of Engrs., vol. 17, no. 2, Sept. 1918, pp. 19-26. Methods of economics as applied to engineering; comparison of American and South African units for passenger traffic.

Resistance

The Mechanics of Curved Resistance. Ry. Rev., vol. 63, no. 15, Oct. 12, 1918, pp. 527-531, 2 figs. A study, covering older theories with data of recent experiments. From paper by J. G. Sullivan contributed to Bulletin 207 of Am. Ry. Eng. Association. Also in Ry. Age, vol. 65, no. 15, Oct. 11, 1918, pp. 665-666.

Shops

Machining Locomotive Driving Boxes, Frank A. Stanley. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 573-575, 11 figs. Outline of work as performed at the Sacramento shops of Southern Pacific.

New Devices in Soo Wheel Shop. Ry. Mech. Eng., vol. 92, no. 10, Oct. 1918, pp. 577-579, 5 figs. Shifting platforms at press and automatic discharging axle carrier add to efficiency of plant.

The Manufacture of Laminated Springs. Ry. Gaz., vol. 29, no. 15, Oct. 11, 1918, pp. 388-390, 4 figs. General layout of locomotive smithy and steam hammer shops.

Signaling

New Electric Interlocking at Clyde, Ill. Ry. Signal Engr., vol. 11, no. 10, Oct. 1918, pp. 306-307, 5 figs. Plant on Chicago, Burlington & Quincy for handling increased main line and yard movement due to heavier traffic.

Tenders

New Tender for Canadian Pacific Locomotives. Ry. Rev., vol. 63, no. 15, Oct. 12, 1918, pp. 525-526, 2 figs. Dimensioned drawing and general description.

Ties

Present Aspect of the Tie Situation. Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 494-495. Principles governing buying and specification of cross ties and difficulties of correct price fixing. From remarks by John Foley at Annual Roadmasters' convention, Chicago, Sept. 1918.

Reinforced Concrete Ties on Southern Pacific. Ry. Rev., vol. 63, no. 16, Oct. 19, 1918, pp. 557-558, 4 figs. Practical solution of

problem faced in present-day shortage of wooden ties.

See also Metal-Working Tools (Locomotive Repair Tools).

REFRACTORIES

Silica Bricks

The Manufacture of Silica Brick, H. Le Chatelier and B. Bogitch. Can. Min. Jl., vol. 39, no. 18, Sept. 15, 1918, pp. 314-317. Causes of failure of furnace roofs; why silica brick retains rigidity at high temperature; manufacturing operations. Paper before Am. Inst. of Min. Engineers, Milwaukee.

Tests

The Standardization of Tests for Refractory Materials, Cosmo Johns. Iron & Steel Inst., advance copy, paper 11, Sept. 12-13, 1918, 32 pp., 3 figs. Analysis of fire clays, raw ganisters, quartose, rocks, and manufactured products; analysis of dolomite and magnesite identification of the various forms of silica in silica bricks; porosity, water absorption and specific gravity tests; shrinkage of clays on drying and firing; tensile strength of dried clays; refractoriness and crushing strength. Prepared provisionally by a committee of refractories section of Ceramic Society.

REFRIGERATION

Refrigerating Plant, A. E. F.

Refrigerating Plant, Intermediate Depot for American Army in France, Robert K. Tomlin, Jr. Power, vol. 48, no. 17, Oct. 22, 1918, pp. 596-598, 4 figs. Description of plant to care for 5000 tons of meat.

Throttling of Ammonia

Throttling of Ammonia, Charles H. Herter. Power, vol. 48, no. 15, Oct. 15, 1918, pp. 530-531. Discusses question of whether it is better to regulate several expansion valves singly, or main liquid valve at receiver.

RESEARCH

British Committee

Scientific and Industrial Research. Third Annual Report. Iron & Coal Trades Rev., vol. 97, no. 2636, Sept. 6, 1918, pp. 257. Report of Committee of Privy Council for Scientific and Industrial Research.

British National Physical Laboratory

Research the Mainstay of a Nation's Industries, Richard T. Glazebrook. Can. Machy., vol. 22, no. 16, Oct. 17, 1918, pp. 449-454, 5 figs. Work accomplished by Nat. Research Lab. of England.

The British National Physical Laboratory. Sci., vol. 48, no. 1238, Sept. 20, 1918, pp. 284-287. Brief report of work done during past year in electricity, heat, meteorology, aerodynamics and special research and investigations.

Cotton Manufacturers' Committee

Committee on Industrial Research. Textile World Jl., vol. 54, no. 19, Nov. 9, 1918, pp. 117-119. Report of committee of Nat. Assn. of Cotton Mfrs. on possibilities of research along lines connected with cotton manufacturing industry and best methods to carry it out.

See also Aeronautics (Research).

ROADS AND PAVEMENTS

Asphalt

Maintaining Old Asphalt Pavements in Buffalo, C. E. P. Babcock and J. A. Vandewater. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 325 and 331-332, 2 figs. Average costs of repairs per yard at different ages to date of condemnation. Before Am. Soc. Mun. Improvements.

Cracks

The Prevention of Longitudinal Cracks in Hard-Surfaced Pavements, Wm. C. Perkins. Good Roads, vol. 16, no. 17, Oct. 26, 1918, pp. 158 and 161. Description of patented method of constructing foundations for brick, concrete and other surfacing. Before Am. Soc. Mun. Improvements.

Drainage

Drainage—The Most Important Consideration Entering into Road Construction, J. H. MacDonald. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 327-329 and (discussion) pp. 329-331. Salient features of this question from local investigations. Before Fifth Annual Congress Can. Good Roads Assn.

The Maintenance of Drainage, R. A. Meeker. Good Roads, vol. 16, no. 12, Sept. 21, 1918, pp. 107-108, 2 figs. Its importance in care of roadway.

Fillers

The Choice of Fillers for Block Pavements, John S. Crandell. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 127-130, 5 figs. Types of fillers; functions of a filler; granite block pavement.

Macadam

American Road Building in French War Zone Organized. Robert K. Tomlin. Highway Mag., vol. 9, no. 6, July 1918, pp. 1-3 and 6, 1 fig. Development of methods of constructing water-bound macadam from inspection by United States highway engineers of British and French Systems.

Maintenance Work

How Well-Maintained Roads are Secured, D. H. Winslow and Charles R. Thomas. Am. City, vol. 19, no. 4, Oct. 1918, pp. 266-270, 4 figs. Study of comparative benefits of local and central government in developing good roads, with special reference to North Carolina system of road maintenance.

Organization for Road Maintenance, L. H. Neilsen. Good Roads, vol. 16, no. 17, Oct. 26, 1916, pp. 157-158. Discussion of administration and operation of maintenance work in Michigan, with special reference to patrol system in township. Before Mich. State Good Roads Assn.

Motorized Equipment

The Motor Truck and Trailer in Road and Street Building, Repair and Maintenance. Cement Eng. News, vol. 30, no. 8, Aug. 1918, pp. 24-28. Data taken from records in office of a county engineer.

Repairs

War-Time Road Repairs. Am. City, vol. 19, no. 4, Oct. 1918, pp. 259-261, 2 figs. Necessity of repairing roads and manner of keeping an earth road in satisfactory condition.

Rural Roads

Road Construction in Alberta, J. D. Robertson. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 285-286. Experience in province with rural roads of sand, gravel, etc. Before Eng. Inst. of Can.

Slag

Roads During and After the War. E. Purnell Hooley. Can. Engr., vol. 35, no. 12, Sept. 19, 1918, pp. 265-266. Use of furnace slag as surface course. Before Instn. Mun. & County Engrs.

See also Cement and Concrete (Paving); Accounting (Highways).

SAFETY ENGINEERING

Accidents

Accident Prevention and Safety, a list of new books and articles received in the library of the National Workmen's Compensation Service Bureau, New York, September, 1918, 9 pp.

Foundation for the Assumption that 18 per cent of Industrial Accidents are Due to Defects in Lighting Installation, R. E. Simpson. Am. Gas Eng. Jl., vol. 109, no. 16, Oct. 19, 1918, pp. 364-366. Based on Travelers Insurance Co. records.

Works Accidents, Their Causes and Remedies. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 175. Brief account of investigation conducted on behalf of the Health of Munition Workers' Committee.

Construction Work

Precautions for Reducing Accidents on Construction Work, W. J. Lynch. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, p. 398. Before Construction Section of Nat. Safety Congress.

Dangerous Tools

Dangerous Tools and Appliances, Chesla C. Sherlock. Am. Mach., vol. 49, no. 16, Oct. 17, 1918, pp. 705-707. Review of some court findings on liability of employers.

Explosives

Handling and Storing Explosives, Arthur La Motte. Eng. & Min. Jl., vol. 106, no. 11, Sept. 14, 1918, pp. 488-493. (Nat. Safety Council.)

Fire Protection

Fire Protection of Turbo-Alternators (Protection contre les incendies de turbo-alternateurs), L. Conge. Revue Générale de l'Electricité, vol. 4, no. 10, Aug. 31, 1918, p. 322, 3 figs. Details of method permitting fire extinction by steam jet under pressure.

How Some Important Ship Fires were Fought, with Notes on Tools for Marine Fire-Fighting, Edward J. Worth. Quarterly of Nat. Fire Prevention Assn., vol. 12, no. 2, Oct. 1918, pp. 143-149. Before International Assn. of Fire Engrs.

Maintenance of Sprinkler Equipments during Cold Weather in Western Canada, John Young. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 157-159. Practice in layout of water mains and of heating gravity tanks.

Oil Interrupters and Fire Protection (les interrupteurs à huile et la protection contre l'incendie), P. Torche. Revue Générale de l'Electricité, vol. 4, nos. 9 and 10, Aug. 31 and Sept. 7, 1918, pp. 311-319, 4 figs. and pp. 343-348, 2 figs. Aug. 31: Résumé of tests on interrupters undertaken by the Association Suisse des Electriciens for the purpose of establishing rules for construction use and installation of these apparatus. Sept. 7: Causes of explosion and analysis of American piston type, which, in author's opinion, is the only one safe against internal pressure.

Shipyard Fire Protection. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 126-128. Notes on the organization of the Plant Protection Section of the Am. Fleet Corporation.

The Fire Risk on Vessels, Samuel D. McComb. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 133-142, 2 figs. Study of hazards of marine transportation. From the Weekly Underwriter.

Grinding Wheels

Bursting Grinding Wheels, Chesla C. Sherlock. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 767-769. Decisions of courts under various circumstances.

Health Conditions

Health of English Workmen in Munition Factories (la santé des travailleurs anglais dans les usines de munitions.) Revue Générale de l'Electricité, year 29, nos. 15-16, Aug. 15-30, 1918, pp. 451-452. Brief account of report of special committee appointed by British Government to study health conditions in industries.

Mine Rescue

Mine Rescue Apparatus. Engineer, vol. 126, no. 3272, Sept. 13, 1918, pp. 219-220, 4 figs. Report of a committee appointed to investigate types of breathing apparatus used in coal mines.

Punch Presses

Safe Punch Press Operation, W. W. Roach. Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1076-1077. Elimination of cuts and lacerations; mechanical guards; lighting and arrangement of machinery; safe practices. Paper before National Safety Council, St. Louis, Sept. 1918.

Spontaneous Heating

Spontaneous Heating of Grain and other Foodstuffs (Ueber die Selbsterhitzung von Getreiden und anderen Nährstoffen), J. F. Hoffman. Dinglers polytechnisches Journal, vol. 333, no. 8, Apr. 20, 1918, pp. 63-67, 1 fig.

Water Mains

Leakage from High-Pressure Mains and its Variation with the Pressure. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 286-287, 1 fig. Report of service in fire system of Borough of Manhattan. From Jl. Am. Waterworks Assn.

Protection of Water Mains, Fire Hydrants and Valves in Winnipeg, Thomas H. Hooper. Quarterly of Nat. Fire Protection Assn., vol. 12, no. 2, Oct. 1918, pp. 159-160.

See also Hoisting and Conveying (Cranes); Mines and Mining (Mine Gases).

SANITARY ENGINEERING

Disinfection

Disinfection by Heat. Times Eng. Supp., no. 528, Oct. 1918, p. 207. Type of disinfectors; suggestions on conditions to be observed.

Drainage

Main Drainage and its Relation to River and Harbor Front Improvement, Morris Knowles and J. M. Rice. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 297-302 and 318. Résumé of methods adopted in many of world's leading cities with detailed notes regarding design of Essex border interceptor. Before Am. Soc. of Mun. Improvements.

Plumbing

The Why and Wherefore of Sanitary Engineering, Arthur Bateman. Domestic Eng., vol. 85, no. 1, Oct. 5, 1918, pp. 5-7 and 32, 4 figs. Series on technical and scientific plumbing and sanitation.

Refuse Disposal

Refuse Incinerating Plants and their Operation, H. J. Harder. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 318-320. Tables giving name of city, capacity and other details of plant, and total cost per day.

Sanitation of Grounds

The Sanitation of Rural Workmen's Areas. Am. City, vol. 19, no. 4, Oct. 1918, pp. 275-278, 2 figs. Shows how to insure suitable living conditions for war-time industrial workers. From report of United States Public Health Service.

Sewage

Catch-Basin Cleaning. Can. Engr., vol. 35, no. 13, Sept. 26, 1918, pp. 287-288. Annual report of superintendent of Bureau of Sewers, Chicago.

First Unit of Improved Means of Sewage Disposal for Philadelphia Well Started, W. L. Stevenson. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 629-633, 3 figs. Design features include intercepting sewer partly under pressure, ventilated grit chamber with sand-removing and washing plant, and depressed Venturi meter.

Main Sewage Treatment Plant of Rochester, E. A. Fisher and N. A. Brown. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 326-329. Description and operating data of detritus tanks, Riensch-Wurl screens, Imhoff tanks, sludge beds and power plant. Before Am. Soc. Mun. Improvements.

Miles Acid Treatment of Sewage. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 321-322. Conclusion of report upon experiment with this process.

Operating Sewage Plants. Mun. Jl., vol. 45, no. 17, Oct. 26, 1918, pp. 327-328. Abstract of instructions issued by Texas State Board of Health; tanks, sludge beds, filters, activated sludge: operation records.

Sewage Purification by Activated Sludge Process, W. R. Copeland. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 302 and 315-316. Comparative degrees of purification obtained with different quantities of air.

Sewer Design and Construction. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 130-132, 1 fig. Sewage collection and disposal proposed at Los Angeles harbor; conditions calling for separate or combined sewers.

The Private Sewerage Question, D. H. Wyatt. Can. Engr., vol. 35, no. 14, Oct. 3, 1918, pp. 310-311. Results produced by leaky building drains and building sewers.

Uses and Accomplishments of Chlorine Compounds in Water and Sewage Purification, C. A. Jennings. Am. City, vol. 19, no. 4, Oct. 1918, pp. 296-304, 3 figs. Remarks on comparative value of liquid chlorine and hypochlorite for disinfection of water and sewage.

Water Purification and Sewage Treatment. Mun. & County Eng., vol. 55, no. 4, Oct. 1918, pp. 138-143, 8 figs. Prevention of Imhoff tank foaming at Schenectady; design and construction features of the slow sand water filtration plant at Auburn; chlorination and filtration.

Water Pollution

Salinification of Rivers and Elimination of Waste Liquids from Soda Works (Die Versalzung der Flüsse und die Beseitigung der Kaliabwässer). Journal fur Gasbeleuchtung, year 61, no. 19, May 11, 1918, pp. 221-224.

Pollution of Boundary Waters, F. A. Dallyn. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 323-325. Examination of final report of International Joint Commission. Before Am. Soc. Mun. Improvements.

STANDARDS AND STANDARDIZATION

Aircraft Materials

British Engineering Standards Association. Aeronautics, vol. 15, no. 255, Sept. 4, 1918, pp. 224-226. Report regarding standardization of aircraft materials and parts.

Gearing

Standardization of Gearing, B. F. Waterman. Mech. World, vol. 64, no. 1645, July 12, 1918, pp. 14-15. Outline of details which author thinks may be standardized in each type. (Am. Gear. Mfrs. Assn. Convention.)

Lamp Voltages

The Standardization of Lamp Voltages, Leon Gaster. Illuminating Engr., vol. 11, no. 7, July 1918, p. 170. Announcement of Tungsten Lamp. Assn. proposing simplification in that respect.

See also Marine Engineering (Standardized Ships.)

STEAM ENGINEERING

Boiler Furnace Walls

New Data on Boiler Walls, J. C. Taylor. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 408-409. Dominant factors in erection and operation of boiler-furnace walls.

Boilers

Boiler Room Efficiency, A. H. Blackburn. Publicity Mag., vol. 17, no. 5, Sept. 1918, pp. 7 and 12-13. Suggestions for intensive fuel economy. Paper before Smoke Prevention Assn.

Development of Steam-Boiler Baffles, Albert A. Straub. Power, vol. 48, no. 19, Nov. 5, 1918, pp. 656-659, 9 figs. Examples of baffles developed to obtain maximum economy and capacity consistent with the primary features for which the baffle was designed.

Feeding and Circulating the Water in Steam Boilers, John Watson. Page's Eng. Weekly, vol. 33, no. 735, Oct. 11, 1918, pp. 172-174. Survey of devices developed in recent years. Before Inst. Marine Engrs.

Removing Tubes, Headers and Baffles in Water-Tube Boilers. Power, vol. 48, no. 17, Oct. 22, 1918, pp. 584-590, 12 figs. Detailed directions with illustrations telling how to take out tubes of water-tube boilers, how to put them in, how to go about removing and replacing cast-iron and wrought-iron tube headers and what must be done to put in new brick for the baffling in the tubes.

Condensers

Keeping Condenser Performance up to the Mark, Hartley Le H. Smith. Elec. Ry. Jl., vol. 52, no. 16, Oct. 19, 1918, pp. 694-697, 4 figs. How station engineer can determine economy he should obtain and how he can correct causes of low vacuum.

Economizers

Economizers from the Viewpoint of a Designing and Operating Engineer, Louis R. Lee. Power, vol. 48, no. 18, Oct. 29, 1918, pp. 637-638, 1 fig.

Wear and Tear of Fuel Economizers, Edward Ingham. Colliery Guardian, vol. 96, no. 3014, Oct. 4, 1918, pp. 707. External corrosion; internal corrosion; water hammer; overheating; flue gas explosions; importance of frequent examinations.

Exhaust Steam

Using Exhaust Steam, S. E. Balcome. Power Plant Eng., vol. 22, no. 20, Oct. 15, 1918, pp. 832-835, 3 figs. Value of exhaust steam; limitations of its use; effects of engine efficiency; heat available with various types of engines.

Pumping Engines

Pumping Engines for the Cairo Main Drainage. Engineering, vol. 106, no. 2749, Sept. 6, 1918, pp. 251-252, 9 figs. Drawings of details and general description of quadruple expansion engines.

Turbines

Steam Turbine Development and Tendencies. Elec. Rev., vol. 73, no. 16, Oct. 10, 1918, pp. 612-614, 3 figs. Rapid development of turbine in past giving place to gradual developments affecting economy, reliability, safety and increased capacity.

Steam Turbines for Natural Steam Power Plant at Larderello, Italy. Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 339, 14 figs. General description with drawings and illustrations.

See also Motor-Car Engineering (Steam Motors); Power Plants (Turbo-electric).

STEEL AND IRON

Acid-Resisting Irons

Acid Resisting Irons. Can. Foundryman, vol. 9, no. 8, Aug. 1918, p. 178. Properties and uses of silicon alloys; typical analysis of duriron and tantiron. (See also Tantiron.)

Cast Iron

A Method for the Prevention of Growth in Grey Cast Iron, J. E. Hurst. Iron & Steel Inst., advance copy, paper 10, Sept. 12-13, 1918, 5 pp., 3 figs. Investigation of possibility of removing graphite without subsequent production of cavities in metal by superficial decarburization, oxidation of graphite being followed by liquidation of phosphate eutectic with remaining cavities. Also in Iron & Coal Trades Rev., vol. 97, no. 2638, Sept. 20, 1918, p. 323. Paper before Iron & Steel Inst., Sept. 1918.

Avoiding Shrinkage Troubles in Cast Iron. Can. Foundryman, vol. 11, no. 9, Oct. 1918, p. 264. Suggestions of some foundrymen regarding use of riser on top of casting to provide sufficient metal to prevent shrinking.

Influence of Some Special Constituents on Cast Iron, A. Campion. Foundry Trade Jl., vol. 20, no. 201, Sept. 1918, pp. 467-470. Nickel, chromium, molybdenum, tungsten, boron, and vanadium.

Duriron

See Acid-Resisting Irons.

Electric Steel

Electric Pig Iron from Steel Scrap, Robert Turnbull. Iron Age, vol. 102, no. 17, Oct. 24, 1918, pp. 1026-1027. Paper before Am. Electrochemical Soc., Atlantic City, Oct. 1918.

Electric Steel Making, Arthur V. Farr. Am. Mach., vol. 49, no. 17, Oct. 24, 1918, pp. 753-755, 4 figs. Describing process of making steel electrically and giving analysis of charge at various stages of process and at end of melt. Paper before Am. Drop Forge Assn., Buffalo, N. Y., June 1918.

The Electric Furnace in the Steel Cast Industry, W. E. Moore. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 331-332. Comparative value of crucible melting, open hearth melting, side-blow converter and electric furnace in producing steel.

Hot-Deformation

Influence of Hot-Deformation on the Quantities of Steel, Georges Charpy. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 4, 19 pp., 10 figs. Tensile tests, shock bend tests and notch tests on blooms resulting from three gun metal equal ingots, made in acid furnace and reduced from common original section of 355 x 355 mm., the first to 225 x 225 mm, the second to 165 x 165 mm, and the third to 125 x 125 mm.

Ingots

The Cooling of Steel in Ingot and Other Forms, J. E. Fletcher. Iron & Steel Inst., advance copy, paper 5, Sept. 12-13, 1918, 40 pp., 20 figs. Experimental investigation of laws governing freezing and cooling of steel in metal and sand molds involving the determination of variable speed of cooling, measurements of temperature gredients and contraction, and observations on influence of cooling on crystalline structure. Also in Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 342-344, 6 figs.; Iron & Coal Trades Rev., vol. 97, no. 2638, Sept. 20, 1918, pp. 315-318, 9 figs. Abstract of paper before Iron & Steel Inst., Sept. 1918.

Iron Metallurgy

Some Experiments on the Reaction between Pure Carbon Monoxide and Pure Electrolytic Iron below the A 1 Inversion, H. C. H. Carpenter and C. Coldron Smith. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 3, 53 pp., 39 figs. Investigation under two different sets of conditions: (1) those in which gaseous products were removed continuously by passing a stream of carbon monoxide over the iron, and (2) tohe in which they were allowed to accumudate in apparatus.

Malleable Iron

Phosphorus in Malleable Cast Iron, J. H. Teng. Iron & Steel Inst., advance copy, paper 16, Sept. 12-13, 1918, 19 pp., 13 figs. Experiments at University of Birmingham on two series of test-bars: (1) by adding phosphoric iron to a very pure American washed white iron, (2) by adding the same to iron supplied by Birmingham malleable iron founders.

The Addition of Steel to Cast Iron, J. E. Hurst. Sci. Am. Supp., vol. 86, no. 2232, Oct. 12, 1918, p. 235. Experiments illustrating absorption of carbon by steel during melting in cupola; results obtained on melting steel borings and crop ends from smithy in a cupola together with 10 per cent ferro silicon. Also in Engineer, vol. 126, no. 3266, Aug. 2, 1918, p. 93.

Open-Hearth Furnace

The Principles of Open-Hearth Furnace Design, Chas. H. F. Bagley. Iron & Steel Inst., Sept. 12-13, 1918, advance copy, paper 1, 19 pp., 5 figs. Discussion from scientific and practical points of view in the light of author's 15 years' experience in England, Germany and United States. Also in Iron & Coal Trades Rev., vol. 97, no. 2637, Sept. 13, 1918, 5 figs.

Pyrometry

Pyrometry Applied to the Hardening of High Speed Steels, J. O. Arnold. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 271-275. Results obtained at Sheffield University using an average temperature of 1300 deg. cent.

Quenching

Note on the Warping of Steel through Repeated Quenching, J. H. Whiteley. Iron & Steel Inst., advance copy, paper 17, Sept. 12-13, 1918, 4 pp., 7 figs. Photographs showing change of shape of a cylindrical piece, weighing several pounds, which has been used for four years for warming small tank after being heated to blood-red heat. Also in Engineering, vol. 106, no. 2752, Sept. 27, 1918, pp. 340-341, 7 figs.

Spectra

A Comparative Study of the Flame and Furnace Spectra of Iron, G. A. Hemsalech. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 213, Sept. 1918, pp. 209-230, 7 figs. Experimental research leading autnor to conclude that iron spectra given by an electric-tube resistance furnace at atmospheric pressure and up to 2400 deg. cent. are caused by action of heat on a chemical compound of the metal and not on the free metal itself, that flame and furnace spectra are identical up to 2400 deg. cent., that the character of spectrum is independent of the nature of iron compound, and other similar results.

Steel

Composition and Properties of Steels, Howard Ensaw. Am. Mach., vol. 49, no. 15, Oct. 10, 1918, pp. 669-672, 1 fig. Composition of steels used for manufacture of various parts of intricate special machinery, especially airplane engines, requiring materials possessing

unusually high tensile strength and shock-resisting qualities.

Iron, Carbon, and Phosphorus, J. E. Stead. Iron & Steel Inst. of Can., vol. 1, no. 8, Sept. 1918, pp. 323-333, 23 figs. Effect of introducing carbon, by cementation, into homogeneous solid solutions of iron and phosphorus; temperature ranges in which free phosphide of iron passes in and out of solid solution in iron. Before Iron & Steel Inst.

Non-Metallic Inclusions: Their Constitution and Occurrence in Steel, Andrew McCance. Iron & Steel of Can., vol. 1, no. 9, Oct. 1918, pp. 374-388, 35 figs. Experimental study of part played by inclusions in developing weaknesses and producing defects in steel products. (To be concluded.)

Note on Certain Colored Interference Bonds and the Colors of Tempered Steel, A. Mallock. Proc. Roy Soc., vol. 94, no. A664, Aug. 1, 1918, pp. 561-566, 2 figs. Scientific explanation of interference phenomena observed with two sheets of gauze when their distance is gradually altered.

The Influence of some Elements on the Tenacity of Basic Steel, with a new Formula for Calculating the Maximum Load from the Composition, Andrew McWilliam. Iron & Steel Inst., advance copy, paper 13, Sept. 12-13, 1918, 13 pp., 3 figs. Formula for sections that would give results near to those obtained on 1-in. round bars normalized, table showing effect of carbon between 0.1 and 0.75. and results of application of formula to certain series of steel.

Tantiron

Tantiron; Am. Acid Resisting Ferro-Silicon Alloy. Can. Machy., vol. 20, no. 17, Oct. 24, 1918, pp. 477-480, 8 figs. Properties, limitations, corrosion, molding and specialties. (See also Acid Resisting Irons.)

Testing

The Applicability of Electrical Resistance Measurements for the Investigation of Iron and Steel (Om användbarheten av elektriska motstandstmätningar för undersökning av jarn och stal), B. D. Enlund. Jern-Kontorets Annaler, Nos. 3-4, 1918, pp. 165-221, 46 figs.

The Magnetic Analysis as a Means of Studying the Structure of Iron Alloys, Kôtaro Honda. Iron & Steel Inst., advance copy, paper 9, Sept. 12-13, 1918, 43 pp., 46 figs. Method based on following experimental facts: (1) the intensity of magnetization of simple homogeneous ferro-magnetic substances decreases at first slowly and subsequently more and more rapidly as temperature increases, and it vanishes at the critical temperature; (2) the critical temperature of a ferro-magnetic element or compound is a characteristic of substance independent of external conditions; (3) the magnetic susceptibility of a substance is abruptly changed when it undergoes an allotropic transformation.

Tuyeres

A Few Notes on Bosh Tuyeres, J. Hollings. Iron & Steel Inst., advance copy, paper 8, Sept. 12-13, 1918, 9 pp., 2 figs. Account of circumstances which led to adoption by author of bosh tuyeres, in 48-ft. furnace at Brymbo.

See also Railroad Engineering, Steam (Rails); Corrosion (Iron).

TERMINALS

Chicago

The Pennsylvania's New Goods Depot at Chicago. Ry. Gaz., vol. 29, no. 12, Sept. 20, 1918, pp. 304-307, 4 figs. Layout of tracks, general plans of floors and cross-sections.

Large Cities

Urges Study of Unit Operation of Railroad Terminals in Large Cities. Eng. News-Rec., vol. 81, no. 14, Oct. 3, 1918, pp. 615-619. Yards and Terminals Committee, Railway Engineering Assn., presents a special report recommending investigation by representative committees of possibilities of coördinating existing facilities.

St. Paul

Engineering at the St. Paul Passenger Terminal. Ry. Rev., vol. 63, no. 17, Oct. 26, 1918, pp. 595-597, 1 fig. New station; elevated tracks eliminating street crossings at grade; coach yard and locomotive terminal.

Toronto

Toronto Union Station an Imposing Structure. Can. Engr., vol. 35, no. 15, Oct. 10, 1918, pp. 319-321, 6 figs. Brief description of chief sub-contracts.

See also Lighting (Factory Lighting).

TESTING AND MEASUREMENT

Cells, Normal

Report on the Weston Normal Cells Exchanged with the Bureau of Standards and the National Physical Laboratory, Jûichi Obata. Department of Communications, Tokyo, Japan, Researches of the Electrotechnical Laboratory, no. 70, May 1918, 11 pp., 1 fig. Method of preparation of cell; three series of comparisons; variation in electromotive force of cell after transportation.

Dynamometers

A 900-Hp. Dynamometer Installation. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, pp. 449-451, 5 figs. Features relating to water cooling, exhaust disposal and dynamometer tests of mammoth engines in test house of Duesenberg Motors Corp. Also in Aviation, vol. 5, no. 6, Oct. 15, 1918, p. 371, 4 figs.

Gases, Temperature

Measuring the Temperature of Gases in Boiler Settings. H. Kreisinger and J. F. Barkley. Department of the Interior, Bureau of Mines, bul. 145, 72 pp., 31 figs. Discussion of various sources of error; manipulation of the potentiometer; list of publications on the utilization of coal and lignite.

Hardness

A New Method of Obtaining Brinell Hardness, J. G. Ayers. Automotive Ind., vol. 39, no. 11, Sept. 12, 1918, p. 457, 2 figs. Impact substituted for steady pressure to reduce time required for applying test.

Report on Hardness Testing: Relation between Ball Hardness and Scleroscope Hardness, A. F. Shore. Iron & Steel Inst., advance copy, paper 15, Sept. 12-13, 1918, 19 pp., 11 figs. Report of tests performed on a variety of metals both ferrous and non-ferrous, with different states of heat-treatment.

Hygrometry

Hygrometry in terms of the Weight of a Film of Gelatine, C. Barns. Science, vol. 48, no. 1241, Oct. 11, 1918, pp. 374-376, 2 figs. Adaptation of form of horizontal torsion balance used by author in measuring absolute viscosity of steel to indications of absorption of atmospheric vapors.

Insulation Resistance

Note on Measuring a Metallic or Insulation Resistance by the Voltmeter Method (Note sur la mesure d'une résistance (métallique ou d'isolement) par la méthode du voltmètre), Puget. Revue Générale de l'Electricité, vol. 4, no. 10, Sept. 7, 1918, p. 298, 2 figs. Indicates two methods to simplify for workingmen calculations involved in application of usual formula $X = R\,\frac{E - v}{u}$, where R is voltmeter resistance, E deviation connecting battery to voltmeter and u deviation with resistance in circuit.

Lead Testing

Lead Testing Machine. Can. Machy., vol. 20, no. 17, Oct. 24, 1918, pp. 484-485, 2 figs. Device consists of cast-iron bed machined all over with two parallel dovetail bearings on top.

Manometers

The Krell Manometer, A. A. Merrill. Aviation, vol. 5, no. 7, Nov. 1, 1918, pp. 421-422, 2 figs. Modification of air-laboratory U-type, in which one branch of U is a glass tube set at a small angle and other branch is a large tank.

Metric System

The International Bureau of Weights and Measures. Sci. Am. Supp., vol. 86, no. 2229, Sept. 21, 1918, pp. 186-187. Motives for creation and special features of metric system. From La Nature.

Pyrometers

The Types and Industrial Uses of Pyrometers. Can. Foundryman, vol. 9, no. 8, Aug. 1918, pp. 179-182, 3 figs. Classification into "contact" and "distant" classes; variation in indications; suitability of different types; location; details of electric circuit; radiation pyrometers.

Sand

Progress Report of Committee on Mechanical Analysis of Sands. Can. Engr., vol. 35, no. 18, Oct. 31, 1918, pp. 387-390. Specifications for standard sieves; methods of making mechanical analysis. From Report of Committee by Am. Water Works Assn.

Shell Steel

Physical Tests of Rolled Shell Steel, James J. Mahon. Iron Age, vol. 102, no. 18, Oct. 31, 1918, pp. 1082-1083, 2 figs. Explanation of frequent results at variance with chemical analysis; excessive precipitation of ferrite corrected by heat treatment.

Testing Machine, Tension and Compression

A Novel Tension and Compression Testing Instrument, Frank C. Perkins. Can. Machy., vol. 20, no. 14, Oct. 3, 1918, pp. 391-392, 6 figs. Device, applicable to wide range of specimen sizes, consists of two adjustable frames, each carrying two screws bearing on gage marks on specimen.

Thread Measurement

Projection Lantern for Thread Measurement, H. L. Van Keuren and E. C. Griess. Am. Mach., vol. 49, no. 18, Oct. 31, 1918, pp. 805-811, 10 figs. Describing an apparatus developed by the Bureau of Standards.

Voltameters

The Richards Form Silver Voltameters, Jûichi Obata. Department of Communications, Tokyo, Japan, Researches of the Electrotechnical Laboratory, no. 71, July 1918, 29 pp., 1 fig. Experimental investigation of the anode compilations in the silver voltameter and determination of voltage of Weston normal cell with Richards form silver voltameter.

See also Brick, Clay and Stone (Abrasion Test); Chemical Technology (Explosives); Hydraulic Engineering (Water Measurements); Lighting (Photometers); Metallurgy (Hardness of Metals); Refractories (Tests); Steel and Iron (Pyrometry); Steel and Iron (Testing).

THERMODYNAMICS

Heat-Transmission Tables

New Heat Transmission Tables, William R. Jones, Heat. & Vent. Mag., vol. 15, no. 10, Oct. 1918, pp. 36-41. Compilation in tabular form of factors given by leading authorities covering latest types of construction.

TIMBER

See Wood.

TRANSPORTATION

Farm Transport

Cheap Transport for Farmers and Rural Industries, Frank Dutton. South African Jl. of Industry, vol. 1, no. 12, Aug. 1918, pp. 1089-1105, 8 figs. Discussion of problem and description of possible solution by means of portable rail tracks for tractors.

Yard Transfer

Operating Methods of Transfer Railroads. Ry. Rev., vol. 63, no. 14, Oct. 5, 1918, pp. 490-493. Analysis of existing conditions and suggestions for improvement to meet demands of increased traffic. From paper by E. H. Lee contributed to preliminary report of Committee on Yards and Terminals, Am. Ry. Eng. Assn., Sept. 1918.

WOOD

Aeroplane Woods

Defects in Airplane Woods, Samuel J. Record. Sci. Am., vol. 119, no. 11, Sept. 14, 1918, p. 212, 5 figs. Method of judging quality of timber.

House Finish

The Uses of Wood (VI), Hu. Maxwell. Am. Forestry, vol. 24, no. 298, Oct. 1918, pp. 593-602, 16 figs. Its employment as house finish.

Kilns

Observation on Kiln Practice, N. S. Potter. Cement & Eng. News, vol. 30, no. 8, Aug. 1918, pp. 35-36. Suggestions as to the points to investigate in connection with raw material, kiln, coal, air, burner, draft and discharged gases, in order to secure efficient operation.

See also Engineering Materials (Precast Concrete Lumber); Fuel and Firing (Wood Burning).

WOOD-WORKING MACHINERY

Tie-Dressing Machine

Machine Dress Railroad Ties Before Treatment. Eng. News-Rec., vol. 81, no. 15, Oct. 10, 1918, 2 figs. Santa Fé stationary and portable plants that saw, adze, bore and brand ties in one continuous operation.

NOTE—The abbreviations used in indexing are as follows: Academy (Acad.); And (&); American (Am.); Associated (Assoc.); Association (Assn.); Bulletin (Bul.); Bureau (Bur.); Canadian (Can.); Chemical or Chemistry (Chem.); Electrical or Electric (Elec.); Electrician (Elecn); Engineer [s] (Engr. [s]); Engineering (Eng.); Gazette (Gaz.); General (Gen.); Geological (Geol.); Heating (Heat.); Industrial (Indus.); Institute (Inst.); Institution (Instn.); International (Int.); Journal (Jl.); London (Lond); Machinery (Machy.); Machinist (Mach.); Magazine (Mag.); Marine (Mar.); Materials (Matls.); Mechanical (Mech.); Mining (Min.); Municipal (Mun.); National (Nat.); New England (N. E.); New York (N. Y.); Record (Rec.); Refrigerating or Refrigeration (Refrig.); Review (Rev.); Railway (Ry.); Scientific or Science (Sci.); Society (Soc.); United States (U. S.); Ventilating (Vent.); Western (West.); State names (Ill., Minn., etc.); Proceedings. (Proc.); Transactions (Trans.); Supplement (Supp.).

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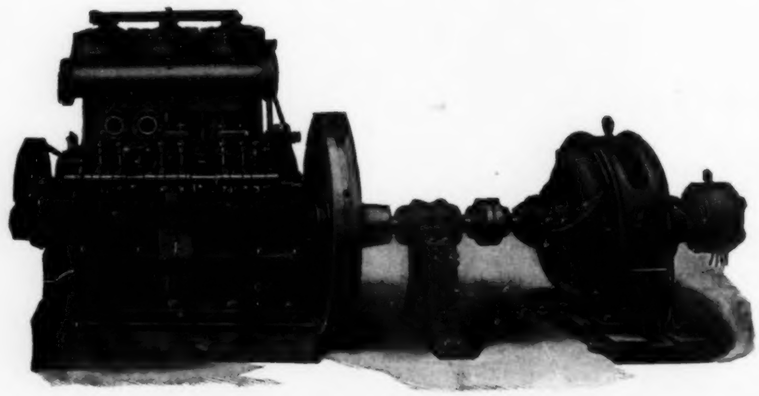
Over 30 years the leader in Vertical Gas Engine Design

NASH GAS ENGINE direct connected by means of flexible coupling to alternating current generator.



NATIONAL METER COMPANY

CHICAGO NEW YORK BOSTON

SEE OUR DATA IN [illegible] A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

"The Standard of Merit"

For Your Power Plant

WHEN considering the installation of new equipment do not overlook the HAMILTON-CORLISS ENGINE. Since 1875 their enviable record for economy, durability and reliability have been steadily maintained and to-day they are to be found in every important manufacturing center because they embody so many good features which are held in the greatest esteem by Power Users.

Our experience of over forty years can be of great benefit to you in selecting a prime mover best suited to your requirements. Eliminate your engine troubles by installing a Hamilton-Corliss Engine. Their records command your investigation.

Write for Bulletin "J.A."

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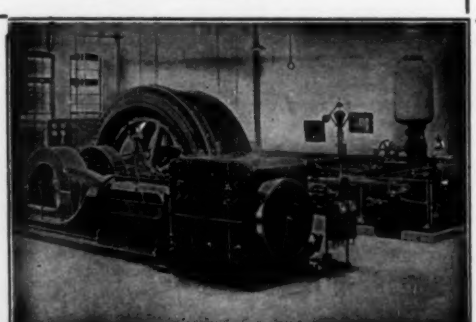

OTTO

UNUSUAL SERVICE

IMPORTANT: As kerosene is cheaper than gasoline, a great saving in operating can be effected by equipping your Otto wick on kerosene burning attachment.

USE OTTO ENGINE OIL and buy your Edison Battery Renewals from us.

MAGNETOS: Consult us before purchasing.

Otto Gas and Gasoline Engines are ever ready for light or heavy loads, for emergencies or steady service.

They are powerful, reliable and economical. Rarely need repairs.

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Give continuous, unusual service. 100,000 in use. Stock designs up to 40 H.P. ready for early delivery.

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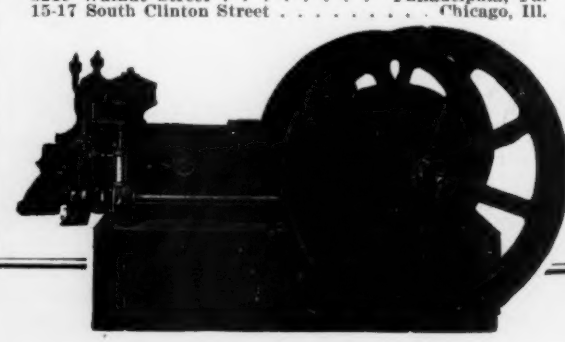
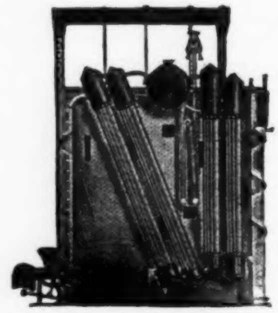


The Bigelow-Hornsby Water Tube Boiler

Features of the Bigelow-Hornsby Boiler that meet the requirements of Modern Power House Practice:

1. Unlimited size of units.
2. Small ground space occupied.
3. Coldest water meets the coldest gases.
4. Direct heating surface about four times as great as the average water tube boiler.
5. All parts, both external and internal, readily accessible.
6. All boiler tubes perfectly straight.
7. Circulation of water and liberation of steam unrestricted.
8. Very dry steam, also ample room for superheaters where required.
9. High continuous economy due to extreme cleanliness of the most efficient heating surface.



Cross Sectional View Through the Brickwork

10. Arrangement of baffling is unique, causing the gases to pass over the heating surface in thin streams and uniformly at every point.
11. Furnace arrangement is ideal for securing perfect combustion, as furnace is correctly shaped and of ample size.
12. Greatest flexibility, both as to construction and in steaming qualities.
13. No cast iron used in any portion of the boiler proper.
14. Constructed both as to workmanship and material in accordance with the most advanced boiler practice.

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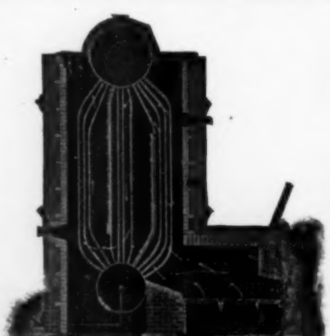
Also Manufacturers of the Bigelow-Manning and Horizontal Return Tubular Boilers, Digesters, Crystallizers, Vulcanizers and Heavy Plate Steel Work

SEE OUR DATA IN 1915 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

SAFER BOILERS



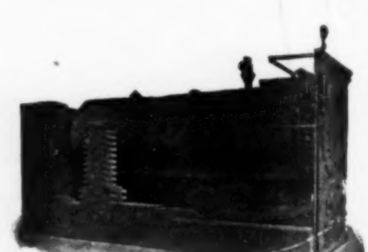
Erie City Vertical Water Tube Boiler

A signal event for the boiler industry was the completion of the A. S. M. E. Boiler Code. This report, containing standard specifications for the construction, equipment and use of steam boilers, embodies the collective knowledge of the world's best experts. Its adoption by the Society marks a new era in the manufacture of steam boilers, and will prove the inauguration of a great movement for the protection of human life and property.

Erie City "Economic" Boiler

Erie City Horizontal Water Tube Boiler

We are now building all types of boilers to meet the specifications of the A. S. M. E. Boiler Code.



Erie City Return Tubular Boiler

ERIE CITY IRON WORKS, Erie, Pa.

Manufacturers of Steam Engines and Boilers and Feed Water Heaters; Horizontal and Vertical Water Tube Boilers; Lentz Engines

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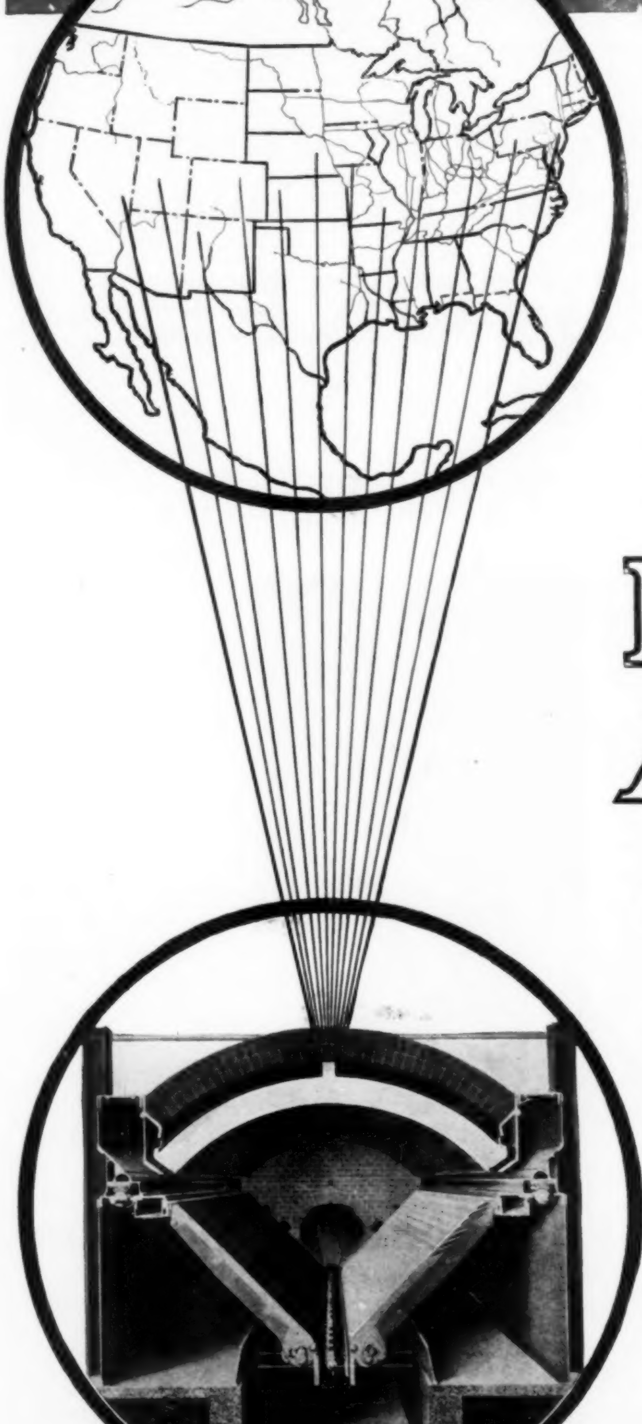
GET IN THE "MURPHY" ZONE



For over forty years engineers and managers have been coming into the Murphy Zone. It is the one means which gives instant and permanent relief to the fuel situation.

Don't think because you are allotted certain fuels from a particular zone that they cannot be burned efficiently and effectively.

The Fuel Administration is well aware of the possibilities of burning *every fuel* in a *properly designed furnace*.

Railroad congestion or winter weather cannot cut off your fuel supply with the Murphy Furnace. You can keep your plant operating on sawdust or even refuse.

The more severe the fuel problem—the shorter the supply—the firmer you will stand by

MURPHY
AUTOMATIC
FURNACES

The Murphy Furnace burns anything that has heat in it. It burns not only one, but many fuels with the highest efficiency.

Consider these points:

It eliminates smoke loss; it is automatic; it requires little attention; it can be adjusted while in operation; it is standard; it is economical, efficient, sensible and can be adapted to any condition.

Above all! The Murphy Furnace operates on natural draft—"Not one penny for draft." Natural draft brings continuous operation of the boilers at the highest point of efficiency.

Remember this—the sooner you get in the Murphy Zone the more quickly you will declare your independence from the fuel problem. Put your combustion problems up to our engineers. Step into the Murphy Zone today.

Catalogue sent upon request.

MANUFACTURED EXCLUSIVELY BY

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

BURNS ANY FUEL THAT HAS HEAT IN IT

The Fuel Problem

5

*The increased cost of repairs, supplies and equipment

Never was the nation's demand for *more power* so urgent as now.

Never was power producing equipment so costly as now.

And the first cost of the TAYLOR Stoker exceeds that of all other stokers.

Yet the United States Government has concentrated *exclusively* on TAYLOR Stokers and stokers of the TAYLOR type for all replacements and new installations of boiler firing equipment.

WHY?

Simply because the Government has learned that only with the TAYLOR type of stoker can a maximum of steam be produced with a minimum of steam making equipment.

The smaller sustained of other types of stokers renders necessary a greater amount of equipment all along the line for the production of a given volume of steam. And the added cost of this increased equipment with its extra space requirements *far exceeds* the saving in first cost effected by buying the lower-priced stoker instead of the high capacity, high efficiency TAYLOR.

So the Government naturally decided that the TAYLOR type of stoker was the cheaper " buy," even at the higher price.

The same reasoning holds good for YOU.

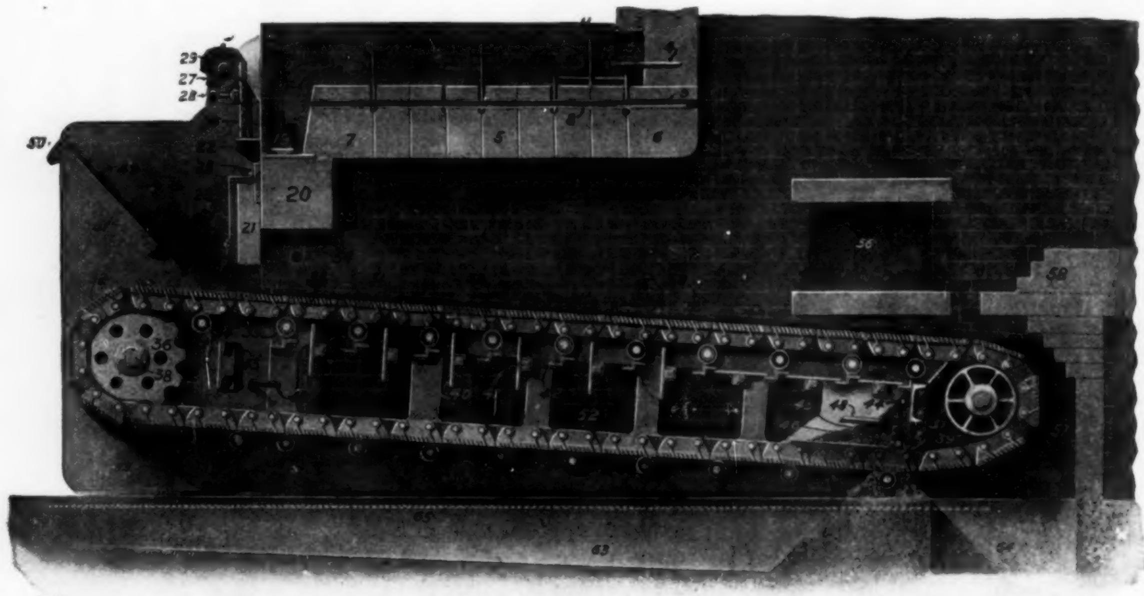
* The five principal causes of the rising cost of producing power, concisely set forth in Mr. A. A. Potter's brilliant paper presented at the Spring Meeting, are:

1. The increased cost of fuel.
2. The necessity of burning fuels of different grades with equipment suitable for one particular grade.
3. The greater amount of ash and other noncombustible matter.
4. The increased cost of labor and the poorer quality of labor available.
5. The increased cost of repairs, supplies and new equipment.

American Engineering Company

Philadelphia

The Taylor Stoker



Efficiency! It's All in the Dampers *Economy!*

TODAY stokers are sold on guarantees covering their performance at loads varying from 50% to 200% of normal rating. *Loads at these ratings* are not merely test conditions, but in most plants they are conditions which are met in daily operation. It is evident that to satisfactorily meet these conditions provision must be made for increasing or decreasing the active grate surface of the stoker in proportion to the boiler load. If this is not done the result is a stoker of proper proportions for a *very small range* of boiler performance only.

On the Illinois Dampered Grate, no matter what load is to be carried, whether it is 25 per cent or 150 per cent of boiler rating, the proper rate of combustion can be maintained. All that is necessary is to suit the effective grate surface to the load by adjusting the dampers. The dampers are movable from the side of the setting and the construction is such that it does not interfere with the withdrawal of stoker from the setting when this is necessary. The dampers can be locked in three positions—closed, half open and wide open—thereby making the air regulation suit any and all conditions.

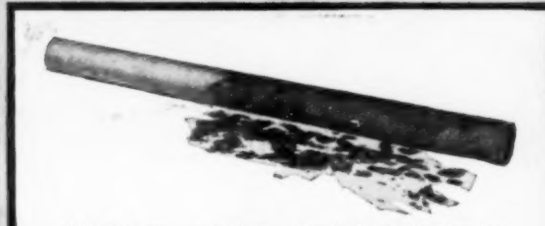
Information and drawings covering your particular installation will be gladly furnished, if you will tell us your requirements.

Illinois Stoker Company

ALTON, ILLINOIS

A glance at the illustrations will show how simply and effectively the Illinois Chain Grate Stoker can be adjusted to meet any load condition that can arise. The dampers—No. 40—are an integral part of the stoker and are turned by means of socket wrenches—No. 62—which extend through pipes, in the setting wall. The ends of the socket wrenches are fitted with adjusting segments—No. 61—by means of which any damper can be adjusted independently. This feature permits of air regulation, both in intensity of draft and in quantity of air, at any portion of the grate.

"Calorizing only will protect soot blower elements from oxidation at high temperatures"

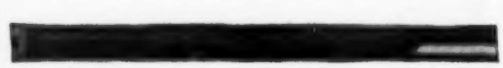


After 30 hours at 1410° F.—One half of this pipe has been treated by the CALORIZING process—the other has not. Which would you employ for high temperatures?

The original Diamond soot blowing element was nothing but a plain iron pipe, with holes drilled at given intervals through which the steam was projected over the fire surfaces of the boiler.

The sheathed unit of a pipe within a pipe was next tried but was not successful.

Next came the insulated element wherein an asbestos filler was inserted between concentric pipes. This met with some little success.



Heat resisting up to 1800° Fahr. without deterioration, Diamond elements are now made of heavy steel tubing which has been calorized.

COSTS MORE AND WORTH MORE

The General Electric Company Says:

"Calorized steel will withstand continuous temperatures of 1800 deg. F. while ordinary iron or steel will begin to disintegrate at 1100 deg. F., and at 1800 deg. its disintegration is extremely rapid. We consider the use of Calorized Metal ESSENTIAL for Soot Blowers."

The word *Essential* as here used by the General Electric Company means certain definite things:

1—That there is no substitute for calorized steel in the blower elements in the hottest passes of the boiler—that *Cast Iron Sheathes* or other attempted means of insulation will not stand the continuous high temperatures.

2—That if attempts are made to use *Cast Iron* or other substitutes for Calorized Steel, the blower elements cannot, on account of the heat, be placed in proper position to clean all of the tubes, but must be withdrawn from locations of efficiency to places of safety.

Calorized steel is a standard feature of Diamond Soot Blowers. In line with the Diamond Company's policy of producing equipment of the highest possible grade, calorized steel was adopted nearly four years ago. In this period of time the demand for Diamond Soot Blowers has so increased that during the year 1918, 225,000 H. P. of boilers monthly have been equipped.

In the average plant Diamond Soot Blowers will effect a saving of 4 to 8 per cent of fuel, an increase in over-all boiler efficiency of 3 to 4 per cent—a saving of 85 per cent of labor and 75 per cent of steam used for cleaning. Both State and National Fuel Administrations recommend their use. If your plant is not equipped with Diamonds, write for Bulletin 119.

DIAMOND POWER SPECIALTY COMPANY
Detroit, Michigan

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

Some Recent Papers on Fuel and Combustion

Title	Author	Year	Order No.	Price
Refuse Destruction by Burning, and the Utilization of Heat Generated	C. N. Russell	1904	1044	.20
Burning of Town Refuse	Geo. Watson	1904	1048	.30
Fuel Economy Tests at a Large Oil Burning Electric Plant	C. R. Weymouth	1908	1213	.20
Unnecessary Losses in Firing Fuel Oil	C. R. Weymouth	1908	1214	.30
Combustion and Boiler Efficiency	E. A. Uehling	1910	1298	.30
Oil Fuel for Steam Boilers	B. R. T. Collins	1911	1307	.40
Topical Discussion on Fuel Oil		1911	1308	.20
Dimensions of Boiler Chimneys for Crude Oil	C. R. Weymouth	1912	1361	.30
Powdered Fuel—(Symposium)		1914	J-36-10	.35
Classification and Heating Value of American Coals	Wm. Kent	1904	1433	.20
The Clinkering of Coal	L. S. Marks	1914	1462	.30
Proportioning Chimneys on a Gas Basis	A. L. Menzin	1916	1518	.20
The Utilization of Waste Heat for Steam-Generating Purposes	Arthur D. Pratt	1916	1550	.40
Pulverized Fuel for Locomotives	J. E. Muhlfeld	1916	1566	.40
Bagasse as a Source of Fuel	E. C. Freeland	1917	1607	.10
Preventable Waste of Coal in the United States	David Moffat Myers	1917	1610	.20
By-Product Coke and Coking Operations	C. J. Ramsburg and F. W. Sperr	1917	1610	.20

Prices to members are one-half those listed

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

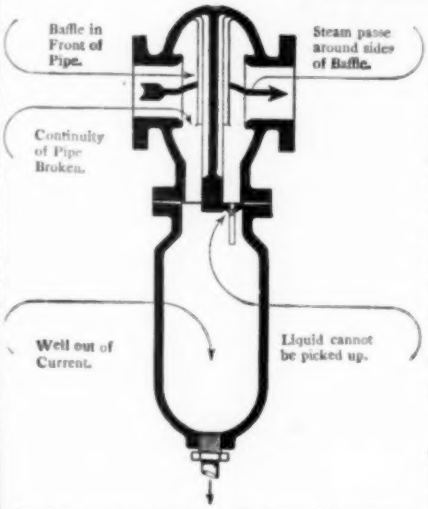
29 WEST 39th STREET, NEW YORK

The Journal of the American Society of Mechanical Engineers

November, 1918 CARD INDEX Vol. 40, No. 11

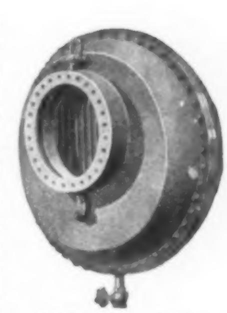
OIL SEPARATION

Facts and Evidence



Section through Cochrane Horizontal Separator.

Exhaust steam from reciprocating engines, pumps, etc., carries oil, partly as small particles suspended in the stream current, and partly as an emulsion flowing along the sides and bottom of the steam pipe. The Cochrane Oil Separator diverts the emulsion into a well or receiver, which the steam does not sweep through, and arrests the flying particles of oil by means of a deeply ribbed baffle, which drains into the well and from which the oil is continually washed by moisture also striking the baffle. The density and momentum of the oil are so much greater than that of an equal volume of steam that when the latter is turned suddenly aside, the oil particles shoot on ahead against the baffle.



Cochrane Horizontal Separator for Vacuum Service.

The efficiency of Cochrane Oil Separators is shown by the fact that over 16,000,000 H. P. of boilers are daily receiving water condensed from steam purified by Cochrane Separators, without experiencing trouble from oil, also by the fact that repeated chemical analyses of the condensate have shown practically complete elimination of oil.

As statements at variance with the facts have been made by persons interested in the sale of various strainers, oil filters, etc., we present the following disinterested testimony of scientists, engineers and others who have made careful investigations:

J. R. Bibbins, speaking before the Detroit Engineering Society on "Separation of oil from condensed steam," said:

"A consideration of the results obtained with the apparatus shown makes it at once apparent that the chemical treatment of the entire condensation is unnecessary, for the reason that but a small proportion out of the total volume of condensation is oily emulsion, and only this proportion therefore requires treatment for entrained oil. **If an efficient oil separator** (Note:—A Cochrane Separator was used.) **be located in the exhaust main at a convenient spot, which will stop all oily emulsion and impurities, whatever then reaches the condenser should be pure steam, and after condensation may be pumped directly back to the boilers as pure feed.**

"The emulsion above mentioned is a mechanical mixture of the most intimate nature of oil and condensed steam. When uncontaminated by black or free oil, the emulsion assumes the appearance of a milky, opalescent liquid with a slight greenish-yellow tinge. Samples drawn from the engine reheater traps on the exhaust system are extremely dense and have more pronounced color than samples from the condensation, which contains such a large percentage of pure condensed steam that no color is apparent, although the liquid still retains its milky or opalescent appearance."

"Samples of the emulsion subjected to the most sensitive tests proved entirely inert, and showed conclusively that the oily mixture obtained from the engine drips and exhaust main is a mechanical mixture of water and oil, but withal so complete a mixture as to appear like a chemical one, showing no evidence of oily or other foreign matter in mechanical suspension."

Darrow Sage writes in Power:

"Water which, in the form of steam, has passed through the cylinders and steam valves of engines and pumps lubricated with cylinder oil carries with it all of the oil that has passed into the cylinders, some of it in the form of drops or small globules of pure oil and the remainder in the form of emulsified or finely divided oil in suspension. The emulsified oil gives the water a milky appearance similar to water that contains air in suspension. In the case of emulsification this milky appearance does not leave the water and **the oil cannot be filtered out by ordinary methods."**

John S. Kirk says in Power:

"**No amount of filtering which is practicable in ordinary steam power plants wiil separate this emulsion** into its elements of water and oil. They go to the boiler together, and while the water is made into steam, the oil is left behind to stick to the tubes and shells and to make all kinds of trouble."

An Editorial Article in Power says:

"When an air pump discharges water, whether from a jet or surface condenser, it will be observed that the water is more or less of a milky color. If such water is filtered through some close fabric, such as felt or filter paper, this appearance will be little if at all affected. This is due to the fact that innumerable tiny globules of oil are suspended throughout the mass of the water, which **globules pass without difficulty through the pores of any filtering material that can be practically employed, therefore the water is not purified from the emulsified oil contained in it."**

C. J. Mathews in Australian Mining Standard says:

"Considering all the evidence available on the subject it is a matter of considerable surprise to find so few efficient oil separators in use. There are a few doing good work, but generally some form of filtration or skimming is relied on, and this method is next to useless, as emulsified **oil cannot be extracted satisfactorily by any known form of filter."**

Edward Ingham in Electrical Times states:

"There are several methods employed for removing grease from boiler feed waters, the commonest of which is perhaps that of filtration of the water by means of grease filters. It is found that most of the oil in the water exists in the form of an emulsion, and microscopic examination reveals the fact that the oily particles are in the form of exceedingly minute elastic globules, the diameter of which is so small i.e., about 1/000,000 of an inch, that it is quite impossible to remove them by mechanical means. **There is no known filtering medium with passages sufficiently small to arrest the minute oily globules, which consequentiy pass forward through the medium and into the boiler."**

While, as these quotations show, oil cannot be removed efficiently after condensation of the steam, **thousands of Cochrane Separators are satisfactorily removing oil from steam before condensation,** and we regularly guarantee that:

Cochrane Oil Service Separators, when installed with regard to the conditions and properly drained, will in either the horizontal or vertical form deliver steam so thoroughly purified from grease or cylinder oil, that this steam can be safely used for heating water by actual contact, for boiler-feed, dye-house and other uses, or that this steam when condensed will be entirely suitable for similar uses.

Efficiency in removing oil from exhaust steam depends upon the methods of installation, as well as upon the separator, as explained in our treatise on "Steam and Oil Separators, Their Design and Uses," sent upon application. Our engineers, upon receipt of particulars concerning your plant, will give you the benefit of thirty years of experience in utilizing exhaust steam for heating buildings, cooking, drying, operation of low pressure turbines, absorption ice machines, heating water for boiler-feeding and other purposes, etc.

Harrison Safety Boiler Works, 3199 N. 17th St., Philadelphia, Penna.

Manufacturers of the celebrated Cochrane Lines, including Open Feed Water Heaters, Steam-Stack and Cut-Out Valve Heaters and Receivers, Metering Heaters and Independent Meters, Sorge-Cochrane Hot-Process Water Softeners, Steam and Oil Separators and Multi-Port Back-Pressure, Atmospheric Relief, Flow and Check Valves.

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84

Protect Your Condensers from Rubbish-Strewn Water

THE importance of uninterrupted power service is greater today than ever before. For the fate of the Nation—the winning of the war—depends largely on the steady supply of power to war munitions makers.

You know the havoc that rubbish in water can work with your condensers—how it endangers equipment—how it can at any time cause a shut-down with its consequent tremendous loss.

Don't continue to take chances. Install a Link-Belt Traveling Water Screen between your water supply and the condensers. It automatically removes all rubbish and debris from the water. Insures steady, uninterrupted operation regardless of water condition. Rigidly constructed to meet most severe service.

Write for Folder No. 305 giving details. Address nearest office.

LINK-BELT COMPANY

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Minneapolis . . . 418 S. Third St.
Kansas City, Mo. . . . 306 Elmhurst Bldg.
Seattle . . . 576 First Ave., S.
Portland, Ore. . . . First and Stark Sts.
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Birmingham, John F. Darrah, 751 Brown-Marx Bldg.
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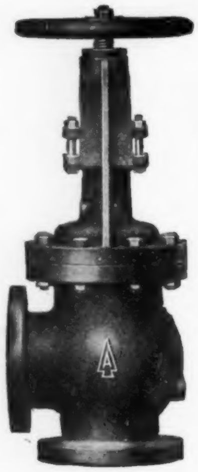
(177)

LINK-BELT

TRAVELING WATER INTAKE SCREENS

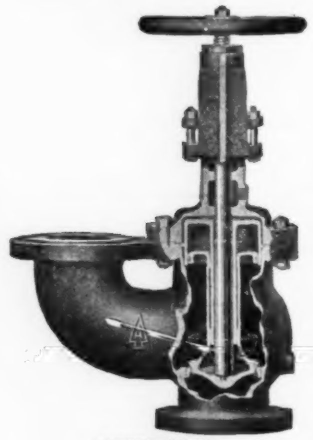
NON-RETURN VALVES

ANGLE VERTICAL or STRAIGHTWAY

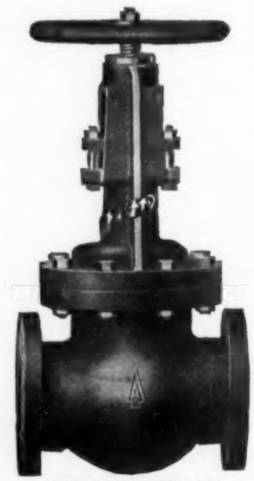

ANGLE

FOR

SUPERHEATED STEAM
CAST STEEL
MONEL MOUNTED


VERTICAL

SATURATED STEAM
SEMI STEEL
BRONZE MOUNTED


STRAIGHTWAY

SPECIAL FEATURES:—

UNDER SIDE OF DASHPOT OPEN TO PREVENT COLLECTING OF SEDIMENT.
EASY FLOW TO REDUCE BACK PRESSURE TO A MINIMUM.
ACCURATE AND POSITIVE ALIGNMENT OF DISC.
BALANCED DISC TO PREVENT HAMMERING.

Complete Piping Systems Furnished and Installed

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION CO.

PITTSBURGH, PA.

1 ENGINEERS FOUNDERS PIPE-FITTERS MACHINISTS

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The Union Connection belongs—

at the valve

No. 1803

CRANE

Regrinding Valves

are important in the equipment of steam plants and locomotives.

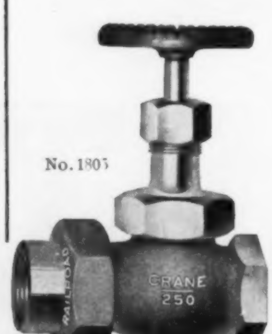
Food will win the war—don't waste it.

No. 1811

NOTE THESE FEATURES:

Extra strong stems,
Deep stuffing boxes,
Malleable iron wheels,
Glands in the stuffing boxes,
Strong, rugged malleable union nut,
Recommended for 250 pounds working pressure.

No. 1805



1855—CRANE CO.—1918

836 South Michigan Avenue, Chicago

Beginning of 14,400 feet of Universal Cast Iron Pipe submerged at Puerto Barrios, Guatemala

U-267

"after investigation showed the Universal Joint was adapted for continuous submerged pipe laying"

it was specified for, and made possible, a badly needed water line 5½ miles in length with a submerged part of 14,400 feet under a bay 24 feet deep.

Space will not permit the enumeration of the many severe obstacles which Universal overcame. Stating the line was laid in Puerto Barrios, Guatemala, and that it averted a water famine is sufficient.

Universal Pipe and the Universal Joint are cast iron of high quality. The contact surfaces of the hub and spigot ends are machined on a taper, giving a natural iron-to-iron joint which is permanently tight.

Specify Universal
"The Cast Iron Pipe That's Different"

Send for handy pocket manual and illustrated literature.

THE CENTRAL FOUNDRY COMPANY
90 WEST ST. NEW YORK

Chicago San Francisco Dallas
Atlanta Kansas City, Mo.

Sirocco Quality and Service

Are exemplified in the announcement that the A. B. Co. can now furnish a kit of fan testing instruments to accommodate the growing demand of fan users for a complete and handy outfit of that nature.

The carrying case, which is compactly and rigidly built, contains all the necessary materials for fan testing. For further details of this outfit write for our publication No. 3506.

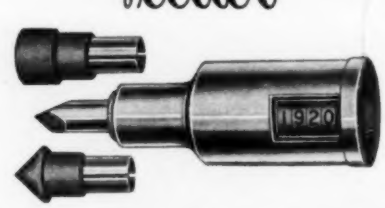
American Blower Company
Detroit, Michigan
BRANCHES IN ALL LARGE CITIES

The Speed Counter Speaks Beforehand

Often the rate of production gives you belated guidance as to machine efficiency, where the rate of speed gives you forehanded guidance *before production starts.*

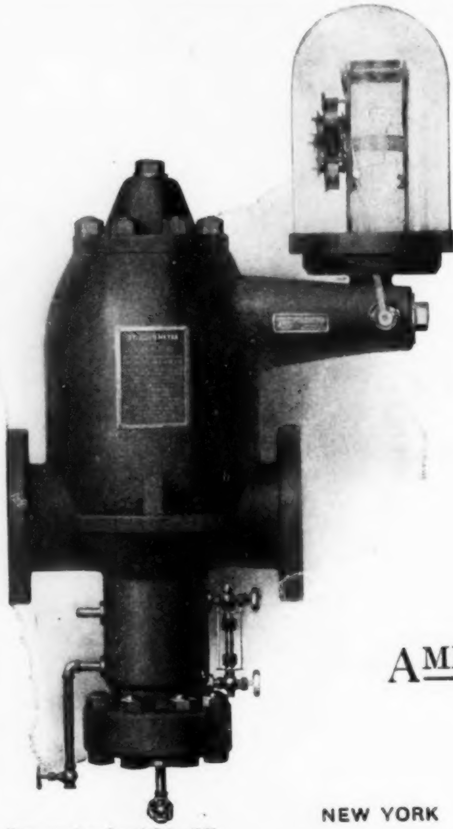
The most handy and accurate-reading Speed Counter is the

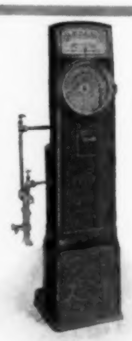
Veeder



Simply hold the tip against revolving shaft or flywheel; apply slight pressure the moment you start timing; release pressure when minute is up. Clutch starts or stops recording mechanism instantly, giving the R. P. M. without use of stop-watch. Price, $3.00. *Ask for the counter catalog.*

The Veeder Mfg. Co.
16 Sargeant St., Hartford, Conn.





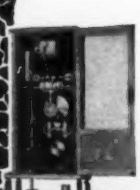
To Measure Is To Economize

In many power plants the cost of fuel for generating 1000 pounds of steam averages 20 cents. In some it's as low as 6 cents.

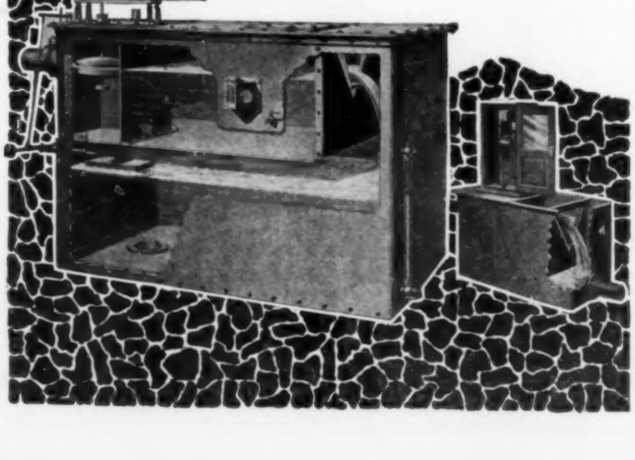
Where does your plant stand? Is this cost as low as it might be? With a Yarway V-Notch with Lea Recorder Meter in your plant, keeping a continuous, accurate check on the quantity of evaporated feed water, you can set boiler-room standards, impossible to attain otherwise.

The Yarway Meter has stimulated economy in hundreds of plants—can probably perform the same service in yours.

Ask our engineers—if the Yarway Meter is not adaptable for conditions in your plant, they'll tell you so.



YARNALL-WARING COMPANY
7610-20 Queen Street
Chestnut Hill Philadelphia



Weighs Each Boiler's Coal

The Beaumont Weigh Larry furnishes an accurate record of the coal supplied to each boiler.

Used in connection with a recording meter on the feed water intake, it furnishes a daily check on the evaporation per pound of coal.

Unlike chutes, it delivers coal from any part of the bunker to any boiler. This is valuable when the bunker supply is small. With closely-set gates there is no dead coal.

"Daily accurate measurements of coal and feed water" are one of the ways named by the Government by which power plant owners can conserve coal to their benefit and the nation's.

Catalog 33 tells more.

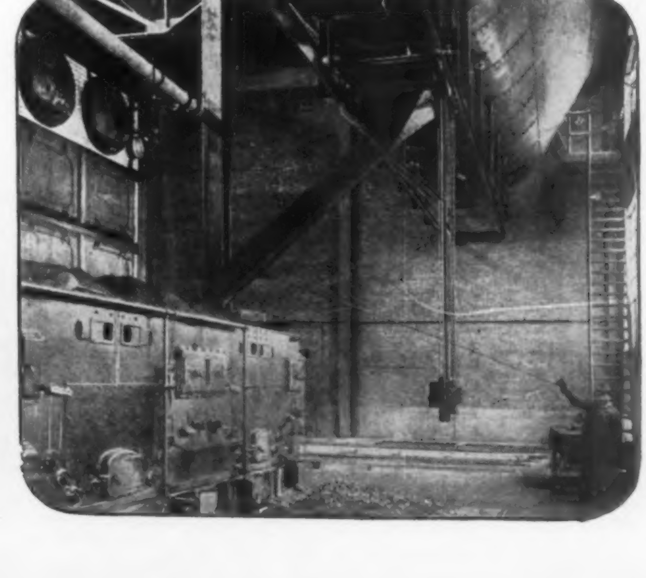
R. H. BEAUMONT CO.

332 Arch St., Philadelphia, Pa.
New York Boston Chicago

Specialists for 25 years in Coal ashes and coke Handling equipment for boiler and gas houses.

Cut shows hand-propelled Beaumont Larry used by National Folding Box and Paper Co., New Haven, Conn.

Beaumont
ONE CONTRACT
ONE RESPONSIBILITY



Number 3 of a series showing applications of the

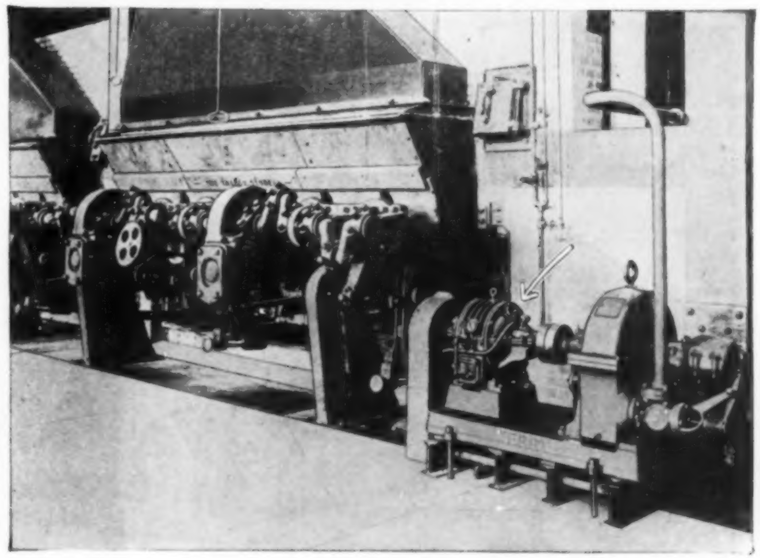
TURBOGEAR

FAST PATENTS

Stoker Drive

Turbo-Gear Steps Up Or Steps Down Speed

The arrow shows the Turbo-Gear



25 H. P. Turbo-Gear reducing the speed of a Terry Turbine from 3500 R. P. M to a Taylor stoker at 500 R. P. M.

A Turbo-Gear-turbine-stoker drive offers the following advantages:

1. Compactness.
2. High efficiency (98%).
3. Light foundations.
4. Practically no attention required.
5. High and low speed shafts in the same straight line.

Turbo-Gears make ideal drives for fans and circulating pumps, too.

SEND FOR BULLETIN 100

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The Poole Engineering & Machine Company

Manufacturers of Gears and Power Transmission Machinery Since 1843

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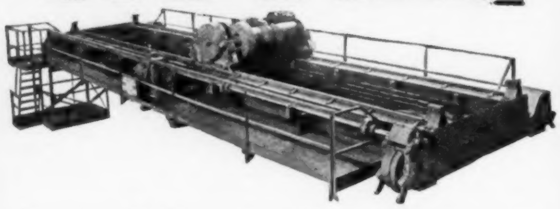
CHICAGO .... Old Colony Building
DALLAS ...... 1405 Southwestern Life Building
DENVER .... First National Bank Building
DETROIT .... 423 Dime Bank Building
EL PASO .... 615 Mills Building
CANADIAN REPRESENTATIVES,
Engineering Company of Canada, Montreal

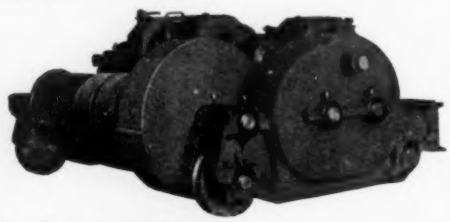
MILWAUKEE .... Wells Building
NEW YORK .... 50 Church Street
PHILADELPHIA .... 929 Chestnut Street
PITTSBURGH ...... 781 Union Arcade Building
ST. LOUIS .... 2211 Olive Street
SALT LAKE CITY .... 218 Judge Building
SAN FRANCISCO .... 503 Mission Street
SEATTLE .... 2012 L. C. Smith Building


Join

NORTHERN CRANES

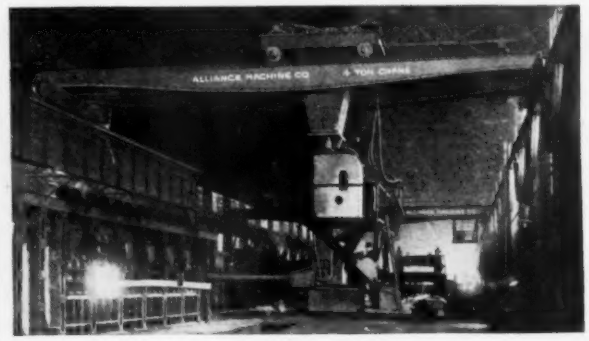


Our type E Cranes for either standard or mill service will interest those who buy and use cranes. Enclosed non-overhung gearing—Simple substantial design—Good workmanship — The "Repeat Order" Crane.



(Also Electric Hoists)

NORTHERN ENGINEERING WORKS
DETROIT MICHIGAN ~ V.S.A.



Economical *Durable*

"ALLIANCE" Crane Type
Billet Charging Machine

Cut shows a machine designed to charge billets and slabs into and draw them from reheating furnaces. It will pick up a slab from any position on the floor and charge it into the furnace.

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9

PITTSBURG *The Largest ... of the World's Largest Cranes* NEW YORK

THE ALLIANCE MACHINE CO.
ALLIANCE, OHIO.
...NGHAM ENGINEERS AND BUILDERS CHICAGO

LIDGERWOOD HOISTS

Steam, Electric, Gasoline

A complete line of standard types and sizes built to fill the severe conditions met in contracting work. Special Hoists to Order.

LIDGERWOOD MFG. CO.
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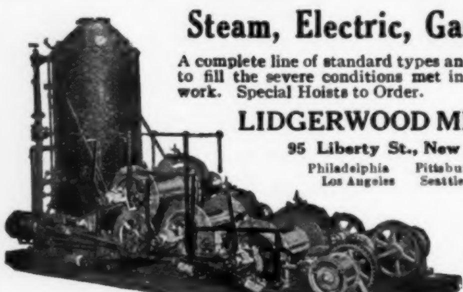

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The Morgan Engineering Co.

ALLIANCE, OHIO

Largest Builders of

Electric Traveling Cranes

in the World

We also design and build Steel Plants complete, Hammers, Presses, Shears, Charging Machines and all kinds of Rolling Mill and Special Machinery.

The Position of the Operator

cannot be improved either for firing the boiler or view of the load and is entirely unobstructed by piping, boom latticing or other obstructions. Another evidence that the designs of

O. S. LOCOMOTIVE CRANES

are the most "up-to-date" on the market and are the result of many years of experience in the design, manufacture and operation of such equipment.

They have been made the standard of many large railroads and other corporations and their popularity is evidenced by a demand for them which has always taxed our producing capacity to the utmost.

ORTON & STEINBRENNER CO.

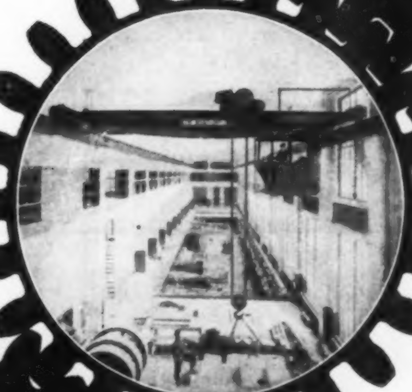
Main Office: CHICAGO, ILL. Works: HUNTINGDON, IND.

5

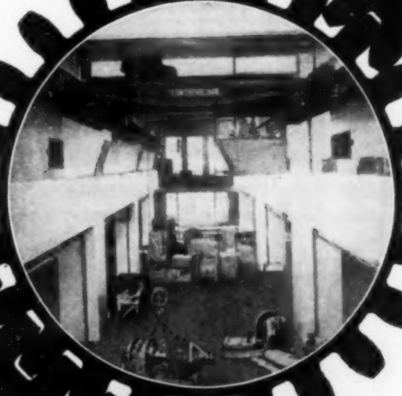
SHEPARD
ELECTRIC CRANES

THEY
ALL AGREE

More than 90 diversified Industries unite in agreeing that SHEPARD ELECTRIC CRANES are the most reliable efficient and economical type of hoisting equipment.

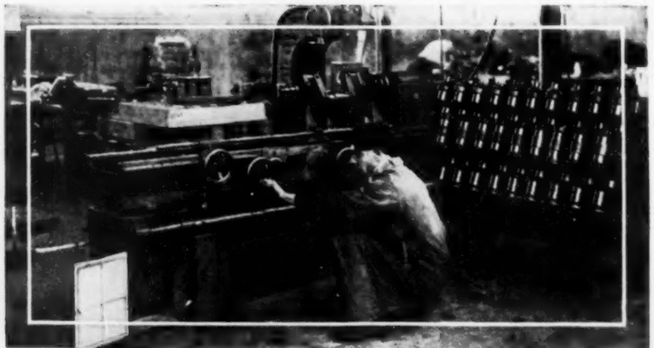


HOIST? BUY A SHEPARD



The distinctive features of SHEPARD design are Balanced Drive; Permanent Alignment; Total Dirt Exclusion; Unit Frames & Enclosures
Consulation with SHEPARD Engineers is free - Write now and *Hoist Buy a SHEPARD*

SHEPARD
ELECTRIC CRANE & HOIST CO.
New-York
Philadelphia
Montour Falls, N.Y.
Chicago
Pittsburgh
Boston, Baltimore, Birmingham, San-Francisco, Montreal, Melbourne, London.



BALANCING MOLINE TRACTOR CRANKSHAFTS

Even in a husky product like a farm tractor vibration is a very important item and manufacturers of the highest grades take great care to secure as near accurate balance of their crankshafts as possible.

To get *static* balance on level ways is a comparatively simple matter, but to find the *running* unbalance of a long cumbersome crankshaft and correct it exactly, has previously been one of the most bothersome problems to both mechanics and engineers.

The above illustration shows how the Moline Plow Works have solved this in their Tractor plant with a

CARWEN

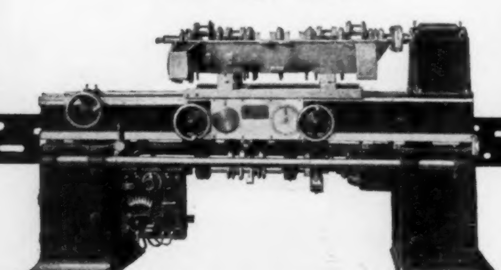
Dynamic Balancing Machine
(AKIMOFF PATENTS)

With ordinary shop skill, it is now possible to accurately locate where and measure exactly how much metal should be added to (or removed from) a crankshaft to put it in precise running balance.

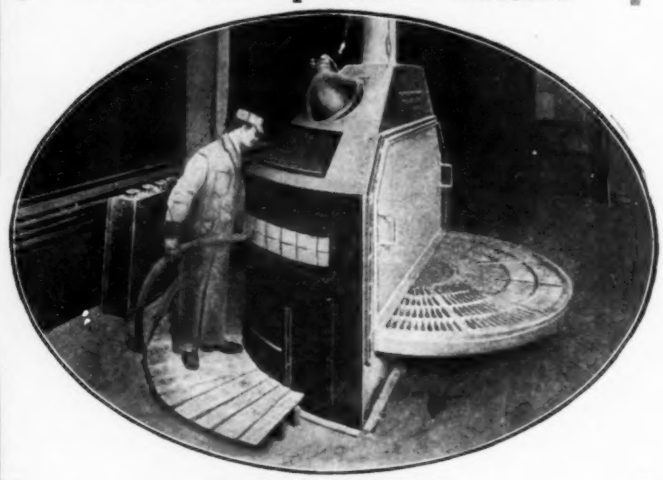
Carwens are being successfully used by the largest electrical concerns for balancing armatures and turbine rotors; by the leading gas engine manufacturers for airplane, passenger car and truck crankshafts, and the cost of purchasing and operating in all cases is practically negligible, as compared with the gain in output and increased efficiency of the product.

Made in sizes suitable for balancing objects weighing up to 15,000 lbs. Write for our illustrated catalog.

CARLSON WENSTROM COMPANY
Erie Avenue at Richmond Street
Philadelphia, Pa.



Every Efficiency and Advantage
OF THE
Room Sand-Blast With the Operator Outside



"PANGBORN"
Type "E H"

Hygienic Cabinet Sand-Blast

Other Types for Any Requirement

PANGBORN CORPORATION
HAGERSTOWN, MD.
SAND-BLAST SPECIALISTS
P. O. BOX 859

DOEHLER DIE-CASTINGS

Accomplish every essential die-casting requirement. Produced by an organization who, for a decade, has made the die-casting manufacture their sole and exclusive aim—the results achieved are amply demonstrated by the extensive and CONSISTENT use of Doehler Die-Castings by the leading manufacturers in all branches of the metal working industries.

DOEHLER DIE-CASTING CO.
BROOKLYN. N.Y.
NEWARK. N.J. TOLEDO. OHIO.

Producers of Die-Castings in Aluminum, Zinc, Tin and Lead Alloys. Also manufacturers of Die-Cast Babbitt Bearings and Babbitt-Lined Bronze Bearings.

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Gages

The continuous flow of supplies to the front is made possible through standardization attained by the use of the limit system of gaging.

This method builds the Liberty Motor. It permits the initial assembly in France of parts from many American factories.

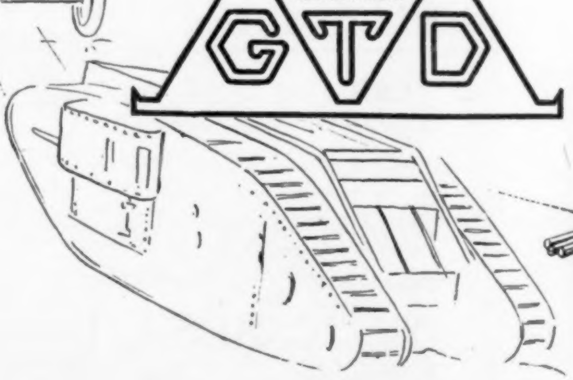
"Gage It"

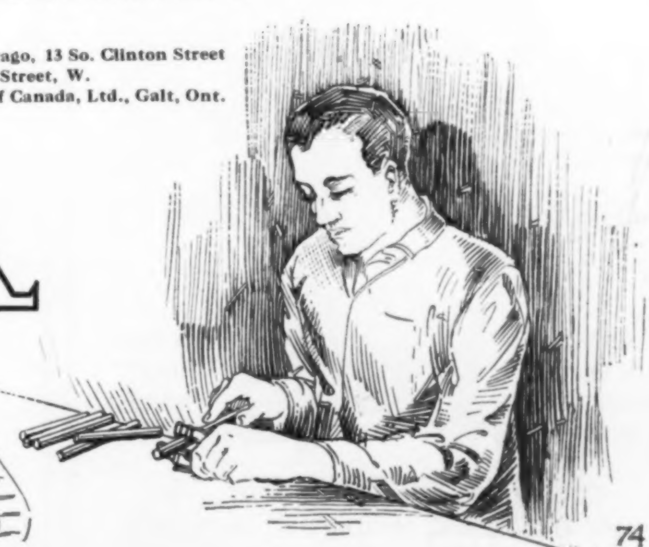
In the development of this system GTD Limit Gages have played an increasingly prominent part.

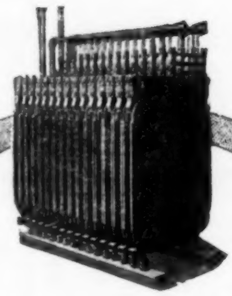
Greenfield Tap and Die Corporation
Greenfield, Massachusetts

STORES
New York, 28 Warren Street — **Chicago, 13 So. Clinton Street**
Detroit Office, 74 Congress Street, W.
Canadian Plant, Wells Brothers Company of Canada, Ltd., Galt, Ont.

REG. U.S. PAT. OFF.
GTD







Economy in the use of oxygen and hydrogen for cutting and welding—essential, by all means. But low cost and uninterrupted supply of gases is just as essential. **You are sure of getting all three,** when you have your own I. O. C. Type 4-1000 Unit Generator plant.

Let us tell you about

"The Cell with Three Times the Capacity Per Unit of Space."

INTERNATIONAL OXYGEN CO

115 BROADWAY, NEW YORK

***Standardized* Apparatus for the Generation and Application of Oxygen and Hydrogen**

THE QUASI-ARC WELDTRODE CO., INC.,

Atlantic Avenue and Warwick Street, Brooklyn, N. Y.,

(Formerly of 107-109 Lafayette Street, New York.)

announces the removal of its offices and factory to its new building in Brooklyn.

In addition to greatly increased manufacturing capacity, the new plant provides complete facilities for chemical and metallographic work, as well as all physical testing apparatus needed to carry out welding tests as prescribed by Lloyd's Registry of Shipping. The Quasi-Arc System of Electric Welding has already passed the required tests and has Lloyd's official sanction.

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"BAKELITE-DILECTO"

It is a perfect Insulating material for high tension work.

It is permanent, strong and practically waterproof.

It is a Laminated Product, and has unlimited possibilities. Its many remarkable qualities adapt it to a wide range of purely mechanical uses.

It is made in Sheets, Rods, Tubes and such special shapes as can be machined from them.

Also makers of high grade VULCANIZED FIBRE and CONITE, the best thin fibrous Insulating material.

THE CONTINENTAL FIBRE COMPANY

NEWARK, DELAWARE

NEW YORK OFFICE
233 Broadway

CHICAGO OFFICE
332 South Michigan Avenue

PITTSBURG OFFICE
301 Fifth Avenue

SAN FRANCISCO OFFICE
525 Market Street

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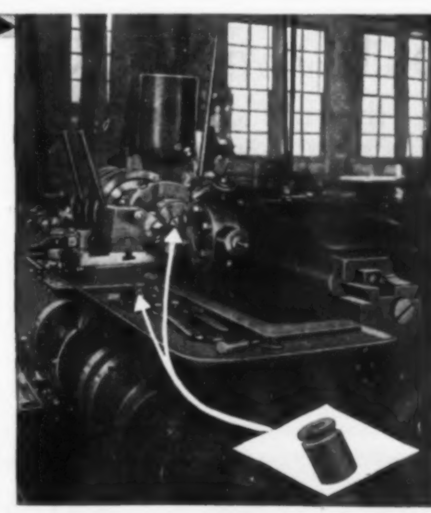

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See pages immediately preceding.

CLASSIFIED LIST OF MECHANICAL EQUIPMENT

Manufactured by Firms Represented in The Journal of the American Society of Mechanical Engineers—For Alphabetical Index, See Page 72

Accumulators, Hydraulic
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.
* Worthington Pump & Machinery Corpn.

Aerial Tramways
(See Tramways, Wire Rope)

Air Brakes, Compressors, Filters, Receivers, etc.
(See Brakes, Compressors, Filters, Receivers, etc., Air)

Air-Jet Lifts
Schutte & Koerting Co.

Air Purifying Apparatus
* American Blower Co.

Air Washers
* American Blower Co.
* Spray Engineering Co.

Alternators
(See Generators, Electric)

Ammeters
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.
* Weston Electrical Instrument Co.

Ammonia Condensers, Fittings, etc.
(See Condensers, Fittings, etc., Ammonia)

Anemometers
* Taylor Instrument Cos.

Annealing
* American Metal Treatment Co.

Anvil Blocks
Hooven, Owens, Rentschler Co.

Anvils, Steel
Hay-Budden Mfg. Co.

Arches, Boiler
* Detrick Co., M. H.

Arches, Ignition (Flat Suspended)
* Detrick Co., M. H.
* Green Engineering Co.

Asbestos Products
* Johns-Manville Co., H. W.

Ash Ejectors
(See Ejectors, Ash)

Axles, Car
* Fuller-Lehigh Co.

Balancing Machines
Carlson-Wenstrom Co.
* Vibration Specialty Co.

Ball Bearings, Gages, etc.
(See Bearings, Gages, Ball)

Balls, Brass and Bronze
* Gwilliam Co.

Balls, Steel
* Atlas Ball Co.
* Gwilliam Co.

Bearings, Ball
Carlson-Wenstrom Co.
* Fafnir Bearing Co.
* Gurney Ball Bearing Co.
* Gwilliam Co.
* Norma Co. of America.

Bearings, Bronze
* American Bronze Corpn.

Bronzes, Bearing
* American Bronze Corpn.

Bearings, Roller
* Gwilliam Co.
* Norma Co. of America.
* Royersford Fdry. & Mch. Co.

Bearings, Self-Oiling
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Doehler Die-Casting Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
* Royersford Fdry. & Mch. Co.
* Wood's Sons Co., T. B.

Bearings, Thrust
Fafnir Bearing Co.
* Gwilliam Co.
* Hill Clutch Co.
* Norma Co. of America.

Belt Dressing
* Schieren Co., Chas. A.
* Texas Co.

Belt Fasteners
* Flexible Steel Lacing Co.

Belt Lacing
* Schieren Co., Chas. A.

Belt Lacing (Hinge)
* Flexible Steel Lacing Co.

Belt Tighteners
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
Smidth & Co., F. L. (Lenix)
* Wood's Sons Co., T. B.

Belting, Chain Link
(See Chain Belts and Links)

Belting, Leather
* Schieren Co., Chas. A.

Benches, Work
Manufacturing Equipment & Engrg. Co.

Bending Machines, Hydraulic
Morgan Engineering Co.

Binder (Lenix)
Smidth & Co., F. L.

Blocks, Tackle
* Clyde Iron Works
* Hunt Co., Inc., C. W.
* Roebling's Sons Co., John A.

Blowers, Centrifugal
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Blowers, Fan
* American Blower Co.
* Green Fuel Economizer Co.

Blowers, Pressure
* American Blower Co.
* Lammert & Mann.

Blowers, Rotary
* Lammert & Mann.
Schutte & Koerting Co.

Blowers, Soot
Diamond Power Specialty Co.

Blowers, Steam Jet
Schutte & Koerting Co.

Blueing
* American Metal Treatment Co.

Boards, Drawing
New York Blue Print Paper Co.

Boiler Coverings, Furnaces, Tube Cleaners, Tubes, etc.
(See Coverings, Furnaces, Tube Cleaners, Tubes, etc., Boiler)

Boiler Settings, Steel Cased
* Casey-Hedges Co.

Boilers, Heating
* Smith Co., H. B.

Boilers, Internal Furnace
* Bigelow Co.
* Casey-Hedges Co.
* Leffel & Co., James
* Springfield Boiler Co.

Boilers, Locomotive
* Bigelow Co.
* Casey-Hedges Co.
* Clyde Iron Works
* Erie City Iron Works
* Lidgerwood Mfg. Co.

Boilers, Marine
* Babcock & Wilcox Co.
* Casey-Hedges Co.

Boilers, Return Tubular
* Bigelow Co.
* Casey-Hedges Co.
* Cole Mfg. Co., R. D.
* Erie City Iron Works
* Springfield Boiler Co.
* Wickes Boiler Co.

Boilers, Vertical Tubular
* Bigelow Co.
* Casey-Hedges Co.
* Clyde Iron Works
* Cole Mfg. Co., R. D.
* Leffel & Co., James
* Lidgerwood Mfg. Co.

Boilers, Water Tube
* Babcock & Wilcox Co.
* Bigelow Co.
* Casey-Hedges Co.
* Edge Moor Iron Works
* Erie City Iron Works
Heine Safety Boiler Co.
* Springfield Boiler Co.
* Wickes Boiler Co.

Bolt Cutters
(See Cutters, Bolt)

Boring Tools
(See Tools, Boring)

Brake Blocks
* Johns-Manville Co., H. W.

Brewers' and Bottlers' Machinery
* Vilter Mfg. Co.

Brick, Fire
Crescent Refractories Co.

Bridge Tramways
(See Tramways, Bridge)

Bridges
Toledo Bridge & Crane Co.

Buckets, Elevator
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
Hendrick Mfg. Co.
Jeffrey Mfg. Co.
* Link-Belt Co.

Buckets, Grab
* Brown Hoisting Machinery Co.
* Clyde Iron Works
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Orton & Steinbrenner Co.

Buckets, Self-Dumping
* Brown Hoisting Machinery Co.
* Clyde Iron Works
* Hunt Co., Inc. C. W.
* Link-Belt Co.
Orton & Steinbrenner Co.

Burners, Oil
* Best W. N.
Schutte & Koerting Co.
* Spray Engineering Co.

Burners, Powdered Fuel
* Quigley Furnace Specialties Co.

Bushings, Bronze
* American Bronze Corpn.

Cabinets and Tables, Blue Print
Manufacturing Equipment & Engrg. Co.

Cable, Wire
(See Rope, Wire)

Cable Railways
(See Railways, Cable)

Cables, Electrical
(See Wire and Cables, Electrical)

Cableways, Excavating
* Lidgerwood Mfg. Co.

Cableways, Hoisting and Conveying
* Lidgerwood Mfg. Co.

Calorimeters
* Precision Instrument Co.
* Sarco Co., Inc.
* Schaeffer & Budenberg Mfg. Co.

Calorimeters, Gas, Recording
Smith Gas Engineering Co.

Car Hauls, Cable and Chain
Jeffrey Mfg. Co.
* Link-Belt Co.

Carriers and Elevators, Freight
* Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
* Link-Belt Co.

Cars, Dump
* Hunt Co., Inc., C. W.

Cars, Freight Elevator
Eastern Machinery Co.

Cars, Industrial Railway
* Hunt Co., Inc., C. W.
* Link-Belt Co.

Cars, Motor
* Hunt Co., Inc., C. W.

Casehardening
* American Metal Treatment Co.

Casings, Steel (Boiler)
* Casey-Hedges Co.

Castings, Brass and Bronze
* American Bronze Corpn.
Crescent Mfg. Co.
* Homestead Valve Mfg. Co.
Lunkenheimer Co.

Castings, Die-Molded
* Doehler Die-Casting Co.
Veeder Mfg. Co.

Castings, Iron
* Brown Co., A. & F.
* Builders Iron Foundry
* Caldwell & Son Co., H. W.
* Central Foundry Co.
* Casey-Hedges Co.
* Cole Mfg. Co., R. D.
* Falls Clutch & Machinery Co.
* Fuller-Lehigh Co.
* Hill Clutch Co.
* Homestead Valve Mfg. Co.
Hooven, Owens, Rentschler Co.
Jeffrey Mfg. Co.
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Lunkenheimer Co.
* Pittsurgh Valve, Fdry. & Const. Co.
* Royersford Fdry. & Mch. Co.

Castings, Semi-Steel
* Builders Iron Foundry
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
Hooven, Owens, Rentschler Co
* Link-Belt Co.
Lunkenheimer Co.

Castings, Steel
Mackintosh, Hemphill & Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1918 Volume*

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CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) **FOR ALPHABETICAL INDEX, SEE PAGE 72**

Cement, Belt
* Schieren Co., Chas. A.

Cement, Refractory
* Johns-Manville Co., H. W.
* Quigley Furnace Specialties Co.

Cement Machinery
* Allis-Chalmers Mfg. Co.
* Caldwell & Son Co., H. W.
* Fuller-Lehigh Co.
* Hill Clutch Co.
* Link-Belt Co.
Smidth & Co., F. L.
* Worthington Pump & Machinery Corpn.

Centrifugal Blowers, Pumps
(See Blowers, Pumps, etc., Centrifugal)

Chain Belts and Links
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
* Link-Belt Co.

Chain Grate Stokers
(See Stokers, Chain Grate)

Chains, Power Transmission
* Baldwin Chain & Mfg. Co.
* Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
* Morse Chain Co.

Charging Machines, Furnace
* Alliance Machine Co.
Morgan Engineering Co.

Chimneys, Steel
(See Stacks, Steel)

Chucking Machines
* Jones & Lamson Machine Co.
Le Blond Machine Tool Co.
* Warner & Swasey Co.

Chutes
Gifford-Wood Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.

Cinder Mills
(See Mills, Cinder)

Circulators, Feed Water
Schutte & Koerting Co.

Circulators, Steam Heating
Schutte & Koerting Co.

Clamps, Pipe
* Yarnall-Waring Co.

Clamps, Wire Rope
(See Wire Rope Fastenings)

Cloth, Tracing
New York Blue Print Paper Co.

Clutches, Friction
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
Eastern Machinery Co.
* Falls Clutch & Machinery Co.
Gifford-Wood Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
* Wood's Sons Co., T. B.

Coal and Ash Handling Machinery
Beaumont Co., R. H.
* Brown Hoisting Machinery Co.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
* Green Engineering Co.
* Hunt Co., Inc., C. W.
Illinois Stoker Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
Orton & Steinbrenner Co.
* Shepard Electric Crane & Hoist Co.

Coal Bins
* Brown Hoisting Machinery Co.
* Link-Belt Co.

Coal Mine Equipments and Supplies
Jeffrey Mfg. Co.

Coal Mining Machinery
Jeffrey Mfg. Co.

Coaling Stations, Locomotive
Beaumont Co., R. H.
Gifford-Wood Co.
* Hunt Co., Inc., C. W.
* Link-Belt Co.

Cocks, Air and Gage
* Ashton Valve Co.
* Crane Co.
* Jenkins Bros.
Lunkenheimer Co.

Cocks, Blow-off
* Crane Co.
* Homestead Valve Mfg. Co.
Lunkenheimer Co.
* Pittsburgh Valve Fdry. & Const. Co.

Cocks, Three-way and Four-way
* Crane Co.
* Homestead Valve Mfg. Co.
Lunkenheimer Co.
* Pittsburgh Valve Fdry. & Const. Co.

Coils, Pipe
* National Pipe Bending Co.
* Vilter Mfg. Co.

Coke Oven Machinery
* Alliance Machine Co.

Cold Storage Plants
* De La Vergne Machine Co.

Collars, Shafting
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Hill Clutch Co.
* Link-Belt Co.
* Royersford Fdry. & Mch. Co.
* Wood's Sons Co., T. B.

Coloring
* American Metal Treatment Co.

Combustion (CO_2) Recorders
Foxboro Co.
* Precision Instrument Co.
Sarco Co., Inc.

Compressor Outfits, Air
* Novo Engine Co.

Compressors, Air
* General Electric Co.
Goulds Mfg. Co.
Hooven, Owens, Rentschler Co.
Mackintosh, Hemphill & Co.
Otto Engine Mfg. Co.
* Worthington Pump & Machinery Corpn.

Compressors, Air, Compound
* Worthington Pump & Machinery Corpn.

Compressors, Ammonia
* Vilter Mfg. Co.
* Worthington Pump & Machinery Corpn.

Compressors, Gas
Hooven, Owens, Rentschler Co.
* Worthington Pump & Machinery Corpn.

Concrete Hardener
Sonneborn Sons, Inc., L.

Concrete Machinery
* Chain Belt Co.

Condensers, Ammonia
* De La Vergne Machine Co.
* Vilter Mfg. Co.

Condensers, Barometric
* Worthington Pump & Machinery Corpn.

Condensers, Jet
Schutte & Koerting Co.
* Worthington Pump & Machinery Corpn.

Condensers, Surface
* Westinghouse Elec. & Mfg. Co.
* Worthington Pump & Machinery Corpn.

Conduit
* Johns-Manville Co., H. W.
Sprague Electric Works

Controllers, Automatic, for Temperature or for Pressure
(See Regulators)

Controllers, Electric
* General Electric Co.
Morgan Engineering Co.
Sprague Electric Works
* Westinghouse Elec. & Mfg. Co.

Converters, Synchronous
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Conveying Machinery
Beaumont Co., R. H.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Lamson Co.
* Link-Belt Co.

Conveyors, Belt
* Caldwell & Son Co., H. W.
Gifford-Wood Co.
Jeffrey Mfg. Co.
* Lamson Co.
* Link-Belt Co.

Conveyors, Bucket, Pan or Apron
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.

Conveyors, Gravity
* Lamson Co.

Conveyors, Ice
Gifford-Wood Co.
* Link-Belt Co.

Conveyors, Screw
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
* Link-Belt Co.

Cooling Ponds, Spray
Schutte & Koerting Co.
* Spray Engineering Co.
Star Brass Works

Cooling Towers
* Spray Engineering Co.
* Worthington Pump & Machinery Corpn.

Copper, Drawn
* Roebling's Sons Co., John A.

Copper, Wire and Cables
(See Wires and Cables, Electrical)

Copper Converting Machinery
* Alliance Machine Co.

Corliss Engines
(See Engines, Steam, Corliss)

Counters, Revolution
* Ashton Valve Co.
Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.

Countershafts
* Builders Iron Foundry
* Hill Clutch Co.
* Wood's Sons Co., T. B.

Counting Machines, Automatic
Veeder Mfg. Co.

Couplings, Flexible
* Falls Clutch & Machinery Co.
* Fawcus Machine Co.
Hooven, Owens, Rentschler Co.

Couplings, Pipe
* American District Steam Co.
* Central Foundry Co.
* Crane Co.
Lunkenheimer Co.

Couplings, Shaft
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Cumberland Steel Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
* Link-Belt Co.
* Royersford Fdry. & Mch. Co.
* Wood's Sons Co., T. B.

Couplings, Union
(See Unions)

Couplings, Universal Joint
* Woods Sons Co., T. B.

Coverings, Steam Pipe
* Johns-Manville Co., H. W.
* Magnesia Assoc. of America.

Cranes, Electric Traveling
* Alliance Machine Co.
Morgan Engineering Co.
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.
Toledo Bridge & Crane Co.

Cranes, Floor (Portable)
* Lidgerwood Mfg. Co.

Cranes, Gantry
* Alliance Machine Co.
* Brown Hoisting Machinery Co.
* Link-Belt Co.
Morgan Engineering Co.
Northern Engineering Works
Orton & Steinbrenner Co.
Toledo Bridge & Crane Co.

Cranes, Hand Power
* Brown Hoisting Machinery Co.
* Clyde Iron Works
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.
Toledo Bridge & Crane Co.

Cranes, Hydraulic
* Alliance Machine Co.

Cranes, Jib
* Alliance Machine Co.
* Brown Hoisting Machinery Co.
Morgan Engineering Co.
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.
Toledo Bridge & Crane Co.

Cranes, Locomotive
* Brown Hoisting Machinery Co.
* Link-Belt Co.
Morgan Engineering Co.
Orton & Steinbrenner Co.

Cranes, Pillar
* Brown Hoisting Machinery Co.
Northern Engineering Works
Orton & Steinbrenner Co.
Toledo Bridge & Crane Co.

Cranes, Portable
* Brown Hoisting Machinery Co.
* Clyde Iron Works
* Link-Belt Co.

Crushers, Coal
* Fuller-Lehigh Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Orton & Steinbrenner Co.
Smidth & Co., F. L.
* Williams Patent Crusher & Pulverizer Co.
* Worthington Pump & Machinery Corpn.

Crushers, Jaw
* Worthington Pump & Machinery Corpn.

Crushers, Roll
Eastern Machinery Co.
Jeffrey Mfg. Co.
Orton & Steinbrenner Co.
* Link-Belt Co.
Standard Equipment Co.
* Williams Patent Crusher & Pulverizer Co.
* Worthington Pump & Machinery Corpn.

Crushing and Grinding Machinery
Allis-Chalmers Mfg. Co.
Fuller-Lehigh Co.
Jeffrey Mfg. Co.
Smidth & Co., F. L.
Standard Equipment Co.
* Williams Patent Crusher & Pulverizer Co.
* Worthington Pump & Machinery Corpn.

Cupolas
* Biglow Co.
Northern Engineering Works

Cutters, Bolt
* Greenfield Tap & Die Corpn.
* Landis Machine Co., Inc.

Cutters, Milling
* Bilton Machine Tool Co.

Cutting-Off Machines, Metal
* Greenfield Tap & Die Corpn.

Damper Regulators
(See Regulators, Damper)

Dehumidifying Apparatus
* American Blower Co.

Derricks and Derrick Fittings
* Clyde Iron Works
* Lidgerwood Mfg. Co.

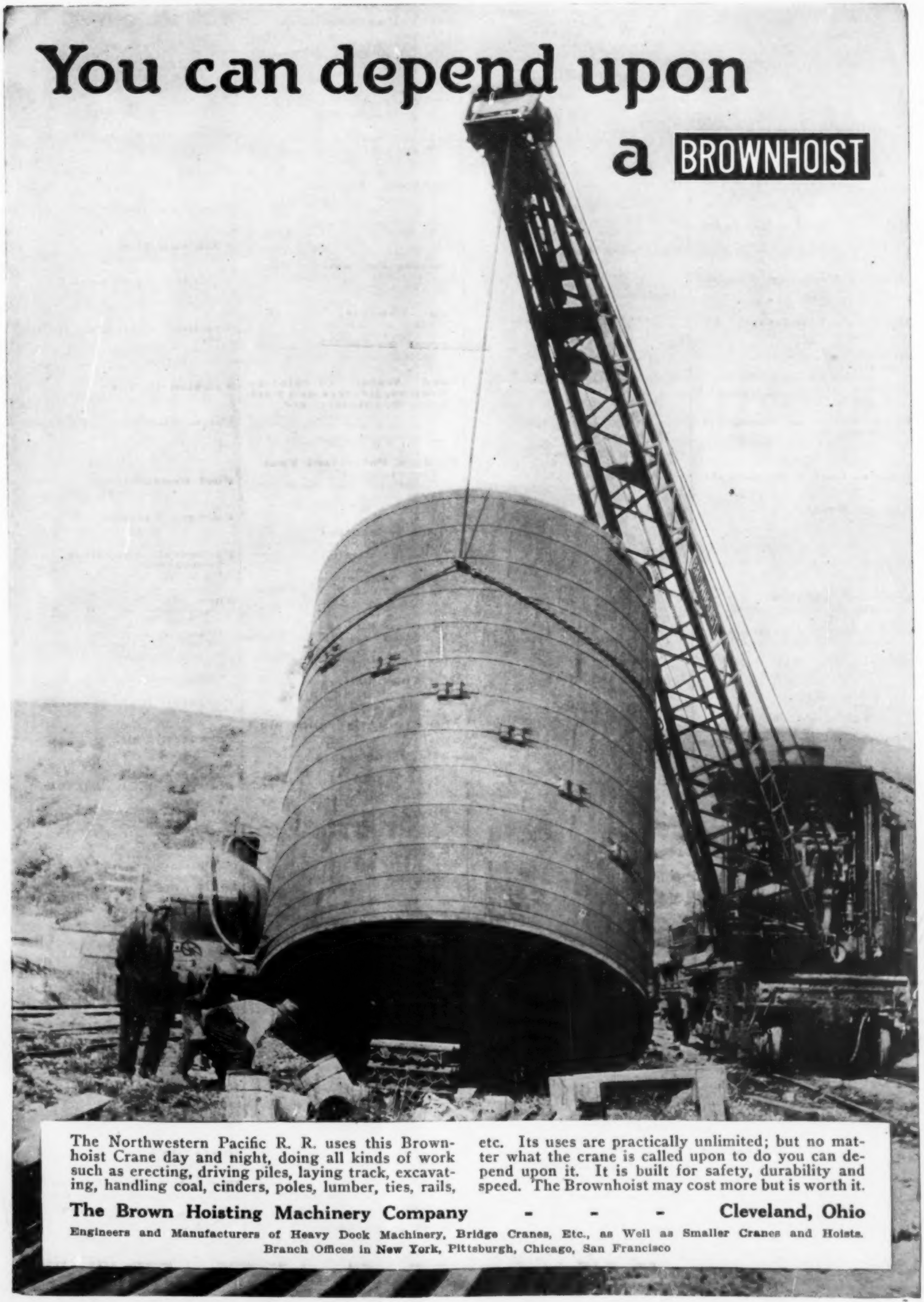
Die Castings
(See Castings, Die)

Dies, Thread Cutting
* Greenfield Tap & Die Corp'n.
* Jones & Lamson Machine Co.
* Landis Machine Co., Inc.

Dies, Thread Cutting (Self-opening)
* Greenfield Tap & Die Corpn.
* Jones & Lamson Machine Co.
* Landis Machine Co., Inc.

Diesel Engines
(See Engines, Oil, Diesel)

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1918 Volume*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CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) FOR ALPHABETICAL INDEX, SEE PAGE 72

Digesters
* Bigelow Co.

Digesters, Pulp
Hooven, Owens, Rentschler Co.

Disintegrators
* Williams Patent Crusher & Pulverizer Co.

Distilling Apparatus
* Hodges Water Still Co., Inc.

Drawing Materials
New York Blue Print Paper Co.

Dredges, Hydraulic
* Morris Machine Works

Drilling Machines, Sensitive
* Bilton Machine Tool Co.
* Royersford Fdry. & Mch. Co.

Drilling Machines, Vertical
* Bilton Machine Tool Co.
* Royersford Fdry. & Mch. Co.

Drills, Coal and Slate
Jeffrey Mfg. Co.

Drinking-Fountains, Sanitary
* Johns-Manville Co., H. W.
Manufacturing Equipment & engrg. Co.

Drop Forgings, Hammers, Presses, etc.
(See Forgings, Hammers, Presses, etc., Drop)

Dryers, Coal (Centrifugal)
* Link-Belt Co.

Dryers, Rotary
* Bigelow Co.
Fuller-Lehigh Co.
* Link-Belt Co.

Dryers, Sand
Pangborn Corporation

Drying Apparatus
* American Blower Co.

Dust Arresting Systems
Pangborn Corporation

Dustproofing Materials
Sonneborn Sons, Inc., L.

Dynamic Balancing Machines
(See Balancing Machines)

Dynamometers, Electric
Sprague Electric Works
* Schaeffer & Budenberg Mfg. Co.

Economizers, Fuel
* Green Fuel Economizer Co.

Ejectors
Lunkenheimer Co.
Schutte & Koerting Co.

Ejectors, Ash, Pneumtic
* Green Engineering Co.

Electric Generators, Hoists, Trucks, Welding, etc.
(See Generators, Hoists, Trucks, Welding, etc., Electric)

Electrical Machinery
* Allis-Chalmers Mfg. Co.
Electro Dynamic Co.
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Electrical Measuring Instruments
(See Instruments, Electrical Measuring)

Electrical Supplies
* General Electric Co.
* Johns-Manville Co., H. W.

Electrical Testing
Electrical Testing Laboratories

Elevating and Conveying Machinery
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
* Hill Clutch Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.

Elevators, Electric
Albro-Clem Elevator Co.
Eastern Machinery Co.
Northern Engineering Works

Elevators, Inclined
(See Carriers and Elevators, Freight)

Elevators, Passenger and Freight
Albro-Clem Elevator Co.
Eastern Machinery Co.
Northern Engineering Works

Emery Wheel Dressers
* Builders Iron Foundry

Engine Stops
Schutte & Koerting Co.

Engineers, Consulting
(See Professional and Educational Directory)

Engines, Blowing
Hooven, Owens, Rentschler Co.
Mackintosh, Hemphill & Co.
* Worthington Pump & Machinery Corpn.

Engines, Gas
* Allis-Chalmers Mfg. Co.
* De La Vergne Machine Co.
Hooven, Owens, Rentschler Co.
* National Meter Co.
* Novo Engine Co.
Otto Engine Mfg. Co.
* Westinghouse Elec. & Mfg. Co.

Engines, Gasoline
* National Meter Co.
* Novo Engine Co.
* Worthington Pump & Machinery Corpn.

Engines, Hoisting
* Clyde Iron Works
* Hunt Co., Inc., C. W.
* Lidgerwood Mfg. Co.
* Morris Machine Works.
Orton & Steinbrenner Co.

Engines, Naphtha
* Allis-Chalmers Mfg. Co.

Engines, Oil
* De La Vergne Machine Co.
Otto Engine Mfg. Co.
* Worthington Pump & Machinery Corpn.

Engines, Oil, Diesel
Otto Engine Mfg. Co.

Engines, Pumping
Hooven, Owens Rentschler Co.
* Morris Machine Works
Otto Engine Mfg. Co.
* Worthington Pump & Machinery Corpn.

Engines, Steam
* Ball Engine Co.
* Clyde Iron Works
* Cole Mfg. Co., R. D.
* Erie City Iron Works
Hooven, Owens, Rentschler Co.
* Leffel & Co., James.
* Lidgerwood Mfg. Co.
Mackintosh, Hemphill & Co.
* Morris Machine Works
* Vilter Mfg. Co.
* Westinghouse Elec. & Mfg. Co.

Engines, Steam, Automatic
* American Blower Co.
* Ball Engine Co.
* Erie City Iron Works
* Leffel & Co., James
* Westinghouse Elec. & Mfg. Co.

Engines, Steam, Corliss
* Allis-Chalmers Mfg. Co.
* Ball Engine Co.
Hooven, Owens, Rentschler Co.
Mackintosh, Hemphill & Co.
* Vilter Mfg. Co.

Engines, Steam, High Speed
* American Blower Co.
* Ball Engine Co.
* Erie City Iron Works

Engines, Steam, Poppet Valve
* Erie City Iron Works
* Vilter Mfg. Co.

Engines, Steering
* Lidgerwood Mfg. Co.

Engines, Traction
* Allis-Chalmers Mfg. Co.

Evaporators
* Hodges Water Still Co., Inc.

Excavating Machinery
* Clyde Iron Works
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Orton & Steinbrenner Co.

Exhausters, Gas
* Green Fuel Economizer Co.
Schutte & Koerting Co.

Exhaust Systems
Pangborn Corporation
* American Blower Co.

Expansion Joints
(See Joints, Expansion)

Extractors, Tar
Smith Gas Engineering Co.

Factory Equipment, Metal
Manufacturing Equipment & Engrg. Co.

Fans, Exhaust
* American Blower Co.
Jeffrey Mfg. Co.
* Green Fuel Economizer Co.
Sprague Electric Works

Feed Water Circulators, Heaters, Heaters and Purifiers, Regulators, etc.
(See Circulators, Heaters, Heaters and Purifiers, Regulators, etc., Feed Water)

Feeders, Pulverized Fuel
* Fuller-Lehigh Co.
* Locomotive Pulverized Fuel Co.
Smidth & Co., F. L.

Fibre, Vulcanized
* Continental Fibre Co.
* Diamond State Fibre Co.

Filters, Water
* Harrison Safety Boiler Works
* Scaife & Sons Co., Wm. B.

Filtration Plants
* Harrison Safety Boiler Works
International Filter Co.
* Scaife & Sons Co., Wm. B.

Fire Tube Boilers
(See Boilers, Return and Vertical Tubular)

Fire Brick, Hydrants, etc.
(See Brick, Hydrants, etc.)

Fittings, Ammonia
* Crane Co.
* De La Vergne Machine Co.
* Vilter Mfg. Co.

Fittings, Flanged
* American District Steam Co.
* Builders Iron Foundry
* Central Foundry Co.
* Crane Co.
Lunkenheimer Co.
Nelson Valve Co.
* Pittsburgh Valve, Fdry. & Const. Co.

Fittings, Hydraulic
* Crane Co.
* Pittsburgh Valve, Fdry. & Const. Co.

Fittings, Pipe
* American District Steam Co.
* Central Foundry Co.
* Crane Co.
Lunkenheimer Co.
National Supply Cos.
* Pittsburgh Valve, Fdry. & Const. Co.

Fittings, Steel
* Crane Co.
Lunkenheimer Co.
Nelson Valve Co.
* Pittsurgh Valve, Fdry. & Const. Co.

Flanges
* American District Steam Co.
* Crane Co.
Lunkenheimer Co.
* Pittsburgh Valve Fdry. & Const. Co.

Flanging Machines
Morgan Engineering Co.

Floor Stands
* Crane Co.
Davis Regulator Co., G. M.
* Hunt Machine Co., Rodney
Lunkenheimer Co.
Nelson Valve Co.
* Pittsburgh Valve, Fdry. & Const. Co.
Schutte & Koerting Co.

Flour Milling Machinery
* Allis-Chalmers Mfg. Co.

Forges
* Best, W. N.

Forgings, Drop
Hay-Budden Mfg. Co.

Forgings, Steel
Hay-Budden Mfg. Co.

Foundry Equipment
Standard Equipment Co.
Northern Engineering Works

Friction Clutches, Hoists, etc.
(See Clutches, Hoists, etc., Friction)

Friction Drives
Rockwood Mfg. Co.

Frictions, Paper and Iron
* Caldwell & Son Co., H. W.
* Link-Belt Co.
Rockwood Mfg. Co.

Fuel Economizers
(See Economizers, Fuel)

Furnace Linings
(See Linings, Furnace)

Furnaces, Annealing and Tempering
* Best, W. N.

Furnaces, Boiler
American Engineering Co.
* Babcock & Wilcox Co.
* Best, W. N.
Combustion Engineering Corpn.
* Green Engineering Co.
* Murphy Iron Works
* Riley Stoker Co., Ltd., Sanford

Furnaces, Heat Treating
* Best, W. N.

Furnaces, Melting
* Best, W. N.

Furnaces, Oil
* Best, W. N.

Furnaces, Smokeless
American Engineering Co.
* Babcock & Wilcox Co.
Combustion Engineering Corpn.
* Green Engineering Co.
Illinois Stoker Co.
* Murphy Iron Works
* Riley Stoker Co., Ltd., Sanford

Fuses
* Johns-Manville Co., H. W.
* General Electric Co.

Gage Boards
* Ashton Valve Co.
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.

Gage Testers
* Ashton Valve Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Ammonia
* Ashton Valve Co.
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Ball
* Atlas Ball Co.

Gages, Differential Pressure
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Foxboro Co.
* Precision Instrument Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1918 Volume*

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) FOR ALPHABETICAL INDEX, SEE PAGE 72

Gages, Draft
* Ashton Valve Co.
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Foxboro Co.
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Taylor Instrument Cos.

Gages, Hydraulic
* Ashton Valve Co.
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Measuring (Surface, Depth, Dial, etc.)
* Atlas Ball Co.
* Norma Co. of America.

Gages, Pressure
* Ashton Valve Co.
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Thread
* Greenfield Tap & Die Corpn.

Gages, Vacuum
* Ashton Valve Co.
Bacharach Industrial Instrument Co.
* Foxboro Co.
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Taylor Instrument Cos.

Gages, Water
* Ashton Valve Co.
* Crane Co.
* Jenkins Bros.
Lunkenheimer Co.

Gages, Water Level
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.

Gas Analysis Apparatus
* Foxboro Co.
* Precision Instrument Co.

Gas Burners, Compressors, Engines, Exhausters, Holders, Producers, etc.
(See Burners, Compressors, Engines, Exhausters, Holders, Producers, etc., Gas)

Gas Cleaning Plants
Smith Gas Engineering Co.

Gas Collectors
* Precision Instrument Co.

Gas Valves
Smith Gas Engineering Co.

Gas Well Supplies
National Supply Cos.

Gaskets
* Goetze Gasket & Packing Co.
* Jenkins Bros.
* Johns-Manville Co., H. W.
* Sarco Co., Inc.

Gasoline
* Texas Co.

Gas Plant Machinery
* Cole Mfg. Co., R. D.

Gates, Cut-off
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Hunt Co., Inc., C. W.
* Link-Belt Co.

Gates, Sluice
* Hunt Machine Co., Rodney
* Pittsburgh Valve, Fdry. & Const. Co.

Gear Cutting Machines
* Bilton Machine Tool Co.

Gear Hobbing Machines
* Bilton Machine Tool Co.

Gear Shapers
* Fellows Gear Shaper Co.

Gear Turning Machines, Bevel
Bridgeport Machine Tool Wks.

Gears, Cut
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Fawcus Machine Co.
Grant-Lees Gear Co.
* Hill Clutch Co.
* James Mfg. Co., D. O.
Jeffrey Mfg. Co.
* Link-Belt Co.
Mackintosh, Hemphill & Co.
New Process Gear Corpn.
Northern Engineering Works
* Poole Engrg. & Mach. Co.

Gears, Fibre
* Continental Fibre Co.
* Diamond State Fibre Co.
* General Electric Co.
* James Mfg. Co., D. O.
New Process Gear Corpn.

Gears, Machine Molded
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Hill Clutch Co.

Gears, Rawhide
* James Mfg. Co., D. O.
New Process Gear Corpn.

Gears, Speed Reduction
* Fawcus Machine Co.
* James Mfg. Co., D. O.
* Poole Engrg. & Mach. Co.
* Westinghouse Elec. & Mfg. Co.

Gears, Worm
Albro-Clem Elevator Co.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Fawcus Machine Co.
Gifford-Wood Co.
* James Mfg. Co., D. O.
* Link-Belt Co.

Generating Sets
* American Blower Co.
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Generators, Electric
* General Electric Co.
Sprague Electric Works
* Westinghouse Elec. & Mfg. Co.

Generators, Oxy-Hydrogen
International Oxygen Co.

Glass Machinery, Plate
Hooven, Owens, Rentschler Co.

Governors, Pump
Davis Regulator Co., G. M.

Governors, Water Wheel
* Hunt Machine Co., Rodney

Granulators
Smidth & Co., F. L.
* Williams Patent Crusher & Pulverizer Co.

Grate Bars
* Casey-Hedges Co.
Combustion Engineering Corpn.
* Erie City Iron Works

Grates, Dumping
Combustion Engineering Corp.

Grates, Shaking
* Casey-Hedges Co.
Combustion Engineering Corpn.
* Erie City Iron Works
* Springfield Boiler Co.

Greases
* Royersford Fdry. & Mach. Co.
* Texas Co.

Grease Cups
(See Oil and Grease Cups)

Grease Extractors
(See Separators, Oil)

Grinding Machines, Chaser
* Landis Machine Co., Inc.

Grinding Machinery
* Brown Co., A. & F.
Jeffrey Mfg. Co.
Smidth & Co., F. L.
* Williams Patent Crusher & Pulverizer Co.

Grinding Machines, Cutter
Le Blond Machine Tool Co.

Grinding Machines, Floor
* Builders Iron Foundry
* Royersford Fdry. & Mach. Co.

Grinding Machines, Tool
Le Blond Machine Tool Co.

Gun and Motor Carriages
Morgan Engineering Co.

Gun Metal Finish
* American Metal Treatment Co.

Hammers, Drop
* Alliance Machine Co.

Hammers, Power
* Beaudry & Co., Inc.

Hammers, Shell Nosing
* Beaudry & Co., Inc.

Hammers, Steam
* Alliance Machine Co.
* Beaudry & Co., Inc.
Morgan Engineering Co.

Hangers, Shaft
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
* Royersford Fdry. & Mach. Co.
* Woods Sons Co., T. B.

Hardening
* American Metal Treatment Co.

Heat Treating
* American Metal Treatment Co.

Heaters, Feed Water (Closed)
* Erie City Iron Works
* National Pipe Bending Co.
Schutte & Koerting Co.
* Worthington Pump & Machinery Corpn.

Heaters and Mixers, Water, Instantaneous
Manufacturing Equipment & Engrg. Co.

Heaters and Purifiers, Feed Water (Open)
* Erie City Iron Works
* Harrison Safety Boiler Works
* National Pipe Bending Co.
* Springfield Boiler Co.
* Wickes Boiler Co.
* Worthington Pump & Machinery Corpn.

Heaters and Purifiers, Feed Water, Metering
* Harrison Safety Boiler Works

Heating Systems, Exhaust Steam
* American District Steam Co.

Heating and Ventilating Apparatus
* American Blower Co.

Hoisting and Conveying Machinery
Brown Hoisting Machinery Co.
* Clyde Iron Works
Gifford-Wood Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Northern Engineering Works
Orton & Steinbrenner Co.
* Shepard Electric Crane & Hoist Co.

Hoisting Outfits
* Novo Engine Co.

Hoists, Air
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.

Hoists, Belt
* Clyde Iron Works
* Lidgerwood Mfg. Co.

Hoists, Chain
* Ford Chain Block & Mfg. Co.
Northern Engineering Works
Yale & Towne Mfg. Co.

Hoists, Electric
Albro-Clem Elevator Co.
* Alliance Machine Co.
* Brown Hoisting Machinery Co.
* Clyde Iron Works
* General Electric Co.
* Hunt Co., Inc., C. W.
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Northern Engineering Works
Orton & Steinbrenner Co.
* Shepard Electric Crane & Hoist Co.
Sprague Electric Works

Hoists, Friction
Eastern Machinery Co.

Hoists, Gas and Gasoline
* Lidgerwood Mfg. Co.
* Novo Engine Co.
Otto Engine Mfg. Co.

Hoists, Head Gate
* Hunt Machine Co., Rodney

Hoists, Mine
* Lidgerwood Mfg. Co.
* Novo Engine Co.

Hoists, Skip
Beaumont Co., R. H.
* Brown Hoisting Machinery Co.
* Hunt Co., Inc., C. W.
* Lidgerwood Mfg. Co.
* Link-Belt Co.

Hoists, Steam
(See Engines, Hoisting)

Hose, Air
Sprague Electric Works

Hose, Metallic
* Johns-Manville Co., H. W.
Sprague Electric Works

Hose, Steam
Sprague Electric Works

Humidifiers
* American Blower Co.

Humidity Control
* American Blower Co.

Hydrants, Fire
* Worthington Pump & Machinery Corpn.

Hydraulic Jacks, Rams, Presses, Turbines, etc.
(See Jacks, Rams, Presses, Turbines, etc., Hydraulic)

Hydraulic Machinery
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.

Hydrogen Gas
International Oxygen Co.

Hydrokineters
Schutte & Koerting Co.

Hydrometers
* Taylor Instrument Cos.

Hygrometers
* Foxboro Co.
* Taylor Instrument Cos.

Ice Making Machinery
* De La Vergne Machine Co.
* Johns-Manville Co., H. W.
* Vilter Mfg. Co.

Ice Tools
* Caldwell & Son Co., H. W.
Gifford-Wood Co.

Idlers (Lenix)
Smidth & Co., F. L.

Indicator Posts
* Crane Co.

Indicators, CO_2
Bacharach Industrial Instrument Co.
Foxboro Co.

Indicators, Engine
Bacharach Industrial Instrument Co.
* Schaeffer & Budenberg Mfg. Co.

Indicators, Speed
Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.
* Weston Electrical Instrument Co.

Industrial Railways
(See Railways, Industrial)

Ingot Strippers
* Alliance Machine Co.
Morgan Engineering Co.

Injectors
Lunkenheimer Co.
Schutte & Koerting Co.

Instruments, Electrical Measuring
* General Electric Co.
* Taylor Instrument Cos.
* Westinghouse Elec. & Mfg. Co.
* Weston Electrical Instrument Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1918 Volume*

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) FOR ALPHABETICAL INDEX, SEE PAGE 72

Instruments, Recording
* Ashton Valve Co.
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Builders Iron Foundry
* Foxboro Co.
* General Electric Co.
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Taylor Instrument Cos.
* Westinghouse Elec. & Mfg. Co.
* Yarnall-Waring Co.

Instruments, Scientific
* Taylor Instrument Cos.

Instruments, Surveying
New York Blue Print Paper Co.

Insulating Materials (Elec.)
* Continental Fibre Co.
* Diamond State Fibre Co.
* Johns-Manville Co., H. W.

Insulating Materials (Heat and Cold)
* Johns-Manville Co., H. W.
* Magnesia Assoc. of America

Irrigation Systems
* Spray Engineering Co.

Joints, Expansion
* American District Steam Co.
* Crane Co.
Lunkenheimer Co.
* Pittsburgh Valve Fdry. & Const. Co.

Joints, Flanged Pipe
* Crane Co.
* Pittsburgh Valve Fdry. & Const. Co.

Kettles, Soda
Manufacturing Equipment & Engrg. Co.

Kettles, Steam Jacketed
* Cole Mfg. Co., R. D.

Kilns, Dry
* American Blower Co.

Ladles
Northern Engineering Works

Lamp Guards (Electric)
* Flexible Steel Lacing Co.

Lamps, Incandescent
* General Electric Co.
* Johns-Manville Co., H. W.
* Westinghouse Elec. & Mfg. Co.

Land-Clearing Machinery
* Clyde Iron Works

Lathe Attachments
Le Blond Machine Tool Co.

Lathes, Automatic
* Jones & Lamson Machine Co.

Lathes, Axle
Bridgefort Machine Tool Wks.

Lathes, Brass
* Warner & Swasey Co.

Lathes, Chucking
* Jones & Lamson Machine Co.

Lathes, Engine
Bridgefort Machine Tool Wks.
* Builders Iron Foundry
Le Blond Machine Tool Co.

Lathes, Journal Truing
Bridgefort Machine Tool Wks.

Lathes, Speed
Le Blond Machine Tool Co.

Lathes, Turret
* Jones & Lamson Machine Co.
* Warner & Swasey Co.

Leather Belting, Packing, etc.
(See Belting, Packing, etc., Leather)

Leather, Friction
* Schieren Co., Chas. A.

Leathers, Pump
* Schieren Co., Chas. A.

Levers, Flexible (Wire)
* Gwilliam Co.

Lightning Arresters
* General Electric Co.

Lining, Brake
* Johns-Manville Co., H. W.

Lining, Furnace
* Best, W. N.
Crescent Refractories Co.
* Johns-Manville Co., H. W.

Lining, Stack
* Johns-Manville Co., H. W.

Liquid Fuel Equipment
* Best, W. N.

Loaders, Wagon
* Chain Belt Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
* Link-Belt Co.

Lockers, Metal
Manufacturing Equipment & Engrg. Co.

Locomotives, Electric
* General Electric Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Westinghouse Elec. & Mfg. Co.

Locomotives, Storage Battery
* General Electric Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Westinghouse Elec. & Mfg. Co.

Logging Machinery
* Clyde Iron Works
* Lidgerwood Mfg. Co.

Lubricants
* Royersford Fdry. & Mach. Co.
* Texas Co.

Lubricators, Cylinder
Crescent Mfg. Co.
* Greene, Tweed & Co.
Lunkenheimer Co.

Lubricators, Force-Feed
* Greene, Tweed & Co.
Lunkenheimer Co.

Lubricators, Hydrostatic
Crescent Mfg. Co.
Lunkenheimer Co.

Machine Work
* Brown Co., A. & F.
Builders Iron Foundry
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
* Lammert & Mann
* Link-Belt Co.

Machinery
(Is classified under the headings descriptive of character thereof)

Magnesia Products
* Magnesia Assoc. of America

Mechanical Draft Apparatus
* American Blower Co.
* Green Fuel Economizer Co.

Mechanical Stokers
(See Stokers)

Metal Equipment
Manufacturing Equipment & Engine Co.

Metal Reclaiming Mills
(See Mills, Metal Reclaiming)

Metal Treating
* American Metal Treatment Co.

Metals, Anti-Friction
* American Bronze Corpn.

Metals, Bearing
* American Bronze Corpn.

Metals, Perforated
Hendrick Mfg. Co.

Meters, Air and Gas
Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Builders Iron Foundry
Foxboro Co.
* General Electric Co.

Meters, Electric
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Meters, Feed Water
* Bailey Meter Co.
* Builders Iron Foundry
* Foxoro Co.
* Harrison Safety Boiler Works
* Yarnall-Waring Co.

Meters, Oil
* Harrison Safety Boiler Works
* Worthington Pump & Machinery Corpn.

Meters, Pilot Tube
* American Blower Co.

Meters, Steam
* American District Steam Co.
* Bailey Meter Co.
* Builders Iron Foundry
* Foxboro Electric Co.
* General Electric Co.

Meters, V-Notch
* Bailey Meter Co.
* Harrison Safety Boiler Works
* Yarnall-Waring Co.

Meters, Venturi
* Builders Iron Foundry
* National Meter Co.

Meters, Water
* Harrison Safety Boiler Works
* National Meter Co.
* Worthington Pump & Machinery Corpn.

Micrometers
* Greenfield Tap & Die Corpn.

Milling Attachments
Le Blond Machine Tool Co.

Milling Machines, Automatic
* Bilton Machine Tool Co.

Milling Machines, Plain
* Bilton Machine Tool Co.
Le Blond Machine Tool Co.
* Warner & Swasey Co.

Milling Machines, Universal
Le Blond Machine Tool Co.

Mills, Ball
* Fuller-Lehigh Co.
Smidth & Co., F. L.

Mills, Blooming and Slabbing
Mackintosh, Hemphill & Co.

Mills, Cinder
Standard Equipment Co.

Mills, Grinding
Jeffrey Mfg. Co.
Smidth & Co., F. L.
* Williams Patent Crusher & Pulverizer Co.

Mills, Metal Reclaiming
Standard Equipment Co.

Mills, Sheet and Plate
Mackintosh, Hemphill & Co.

Mills, Structural, Rail and Bar
Mackintosh, Hemphill & Co.

Mills, Tube
Smidth & Co., F. L.

Mining Machinery
* Allis-Chalmers Mfg. Co.

Mixers, Clay, Fertilizer, etc.
* Williams Patent Crusher & Pulverizer Co.

Mixers, Concrete
* Chain Belt Co.

Monorail Systems
(See Tramrail Systems, Overhead)

Motion Recorders
* Foxboro Co.

Motor-Generators
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Motors, Electric
Electro Dynamic Co.
* General Electric Co.
* Shepard Electric Crane & Hoist Co.
Sprague Electric Works
* Westinghouse Elec. & Mfg. Co.

Nipple Threading Machines
* Landis Machine Co., Inc.

Nozzles, Aerating
* Spray Engineering Co.

Nozzles, Blast
Schutte & Koerting Co.

Nozzles, Sand and Air
Lunkenheimer Co.

Nozzles, Spray
Schutte & Koerting Co.
* Spray Engineering Co.
Star Brass Works

Odometers
Veeder Mfg. Co.

Oil and Grease Cups
* Crane Co.
Crescent Mfg. Co.
Lunkenheimer Co.

Oil Burners, Engines, Filters, Pumps, Separators, etc.
(See Burners, Engines, Filters, Pumps, Separators, etc., Oil)

Oil Burning Equipment
* Best, W. N.
Schutte & Koerting Co.

Oil Refinery Equipment
National Supply Cos.

Oil Tanks
* Scaife & Sons Co., Wm. B.

Oil Well Machinery
National Supply Cos.
* Worthington Pump & Machinery Corpn.

Oil Well Supplies
National Supply Cos.

Oilers, Sight Feed
Lunkenheimer Co.

Oiling Devices
Lunkenheimer Co.

Oiling Systems
Lunkenheimer Co.

Oils, Fuel
* Texas Co.

Oils, Lubricating
* Texas Co.

Ore Handling Machinery
* Brown Hoisting Machinery Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Toledo Bridge & Crane Co.

Oxygen Gas
International Oxygen Co.

Packing, Asbestos
* Johns-Manville Co., H. W.

Packing, Hydraulic
* Greene, Tweed & Co.
* Johns-Manville Co., H. W.
* Schieren Co., Chas. A.

Packing, Leather
* Schieren Co., Chas. A.

Packing, Metallic
* Goetze Gasket & Packing Co.
* Johns-Manville Co., H. W.

Packing, Rod (Piston and Valve)
* Greene, Tweed & Co.
* Jenkins Bros.
* Johns-Manville Co., H. W.

Packing, Rubber
* Jenkins Bros.
* Johns-Manville Co., H. W.

Packing, Sheet
* Goetze Gasket & Packing Co.
* Jenkins Bros.
* Johns-Manville Co., H. W.

Paint, Metal
* Johns-Manville Co., H. W.

Paper, Drawing
New York Blue Print Paper Co.

Paper, Sensitized
New York Blue Print Paper Co.

Pasteurizers
* Vilter Mfg. Co.

Pencils, Drawing
American Lead Pencil Co.
Dixon Crucible Co., Joseph

Penstocks
* Hunt Machine Co., Rodney

Perforated Metals
(See Metals, Perforated)

Petroleum Products
* Texas Co.

Pile Drivers
* Clyde Iron Works
* Lidgerwood Mfg. Co.

Pinions, Rolling Mill
Mackintosh, Hemphill & Co.

Pinions, Rawhide
New Process Gear Corp.

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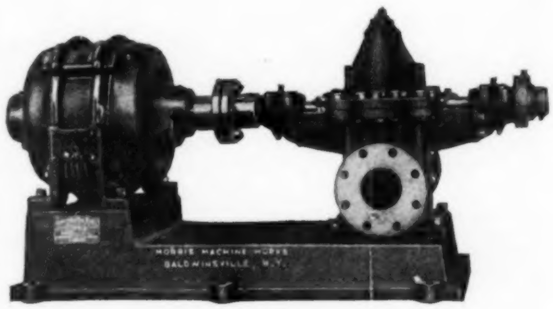


4" Horizontally Split Single-Stage Pump

2

Centrifugal Pumps
Hydraulic Dredges
Steam Engines

MORRIS MACHINE WORKS

BALDWINSVILLE, N. Y., U. S. A.

Agencies in Principal Cities

LAMMERT & MANN CO.

ENGINEERS - MACHINISTS

Wood and Walnut Sts. Chicago, Ill.

MANUFACTURERS OF

Rotary Vacuum Pumps for highest possible Dry Vacuum

Rotary Blowers—Centrifugal Pumps

Contract Work and Builders of Special Machinery

SEND US YOUR BLUE PRINTS

Water Controlling Apparatus

Equipment and Accessories for Water Controlling as required for Canals, Penstocks, Flumes, Irrigation and Sewage Improvements.

Flumes and Penstocks,
Relief Valves and Gauges,
Gates and Valves,
Gate Hoists and Floor Stands,
Trash Racks and Strainers

Catalog sent on request

RODNEY HUNT MACHINE CO.

97 Mill Street, Orange, Mass.

Manufacturers of Turbine Water Wheels, Water Controlling Apparatus, Power Transmission Equipment, Underwriter Rotary Fire Pumps, Textile Wet Finishing Machinery.

THE BIG ISSUE OF THE YEAR

CONTINUING the plan which was inaugurated two years ago, the Annual Meeting of the Society for 1918, which will take place in New York, December 3-6, will be reported entire in the January number of The Journal of the A. S. M. E., making this an issue of exceptional interest and importance to both the reader and the advertiser.

The general engineering papers on hand for this meeting rank among the best of any similar group of papers contributed to the Society in recent years. In addition, there will be a series of stirring addresses by prominent engineers and Government officials on the broad aspects of Management, and bearing on the general subject of "Engineering of Man Power." The report of this Keynote Session will in itself comprise a record and summary of indispensable value; while the account of the general program will constitute practically an expert review of the recent advances in mechanical engineering.

From the advertising standpoint, this issue of The Journal is always the most noteworthy of the year. The plans provide for a number so large and so informative that our members and other readers will find it well worth keeping as an up-to-date compilation covering mechanical equipment and supplies.

In addition to the large volume of advertising matter to be carried, the Classified Index of this issue will comprise a reference feature of much value. Adequate listings in this Index will be included with all orders for space, provided such orders are received sufficiently early to permit of the necessary rearrangements of the Index.

Manufacturers of machinery, apparatus and materials utilized in industrial and power plants are invited to take advantage of the exceptional publicity value of this January Annual Meeting Number by arranging for appropriate space.

Reservations should be sent at an early date to

THE AMERICAN SOCIETY
OF MECHANICAL ENGINEERS

29 West 39th Street, New York

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 72

Pipe, Cast Iron
* American District Steam Co.
* Builders Iron Foundry
* Central Foundry Co.

Pipe, Riveted Steel
* Hunt Machine Co., Rodney
* Springfield Boiler Co.

Pipe, Soil
* Central Foundry Co.

Pipe, Steel
* Crane Co.

Pipe, Welded
* Crane Co.
* Pittsburgh Valve Fdry. & Const. Co.

Pipe, Wood
* American District Steam Co.
* Hunt Machine Co., Rodney

Pipe, Wrought Iron
* Crane Co.

Pipe Coils, Covering, Cutters, Fittings, Joints, etc.
(See Coils, Covering, Cutters, Fittings, Joints, etc., Pipe)

Pipe Cutting and Threading Machines
* Crane Co.
* Greenfield Tap & Die Corpn.
* Landis Machine Co., Inc.

Pipe Joint Clamps
(See Clamps, Pipe Joint)

Pipe Line Supplies
National Supply Cos.

Piping, Power
* American District Steam Co.
* Crane Co.
* National Pipe Bending Co.
* Pittsburgh Valve Fdry. & Const. Co.

Plate Metal Work
(See Steel Plate Construction)

Pneumatic Tubes
* Lamson Co.

Pointers, Bolt
* Landis Machine Co., Inc.

Polishing Machinery
* Builders Iron Foundry
* Royersford Fdry. & Mach. Co.

Poppet Valve Engines
(See Engines, Steam, Poppet Valve)

Powdered Fuel Equipment (for Boiler and Metallurgical Furnaces)
* Fuller-Lehigh Co.
* Locomotive Pulverized Fuel Co.
* Quigley Furnace Specialties Co.
Smidth & Co., F. L.
* Worthington Pump & Machinery Corpn.

Power Transmission Machinery
* Allis-Chalmers Mfg. Co.
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Eastern Machinery Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
* Hunt Machine Co., Rodney
Jeffrey Mfg. Co.
* Link-Belt Co.
* Morse Chain Co.
* Poole Engrg. & Mach. Co.
* Royersford Fdry. & Mach. Co.
Smidth & Co., F. L. (Lenix)
* Wood's Sons Co., T. B.

Presses, Foot
* Royersford Fdry. & Mach. Co.

Presses, Hydraulic
* Alliance Machine Co.
* Falls Clutch & Machinery Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.

Presses, Punching and Trimming
* Royersford Fdry. & Mach. Co.

Pressure Gages, Regulators, etc.
(See Gages, Regulators, etc., Pressure)

Producers, Gas
* De La Vergne Machine Co.
Otto Engine Mfg. Co.
Smith Gas Engineering Co.
* Westinghouse Elec. & Mfg. Co.
* Worthington Pump & Machinery Corpn.

Propellers
* Morris Machine Works

Pulleys, Iron
* Brown Co., A. & F.
* Chain Belt Co.
* Caldwell & Son Co., H. W.
* Falls Clutch & Machinery Co.
Gifford-Wood Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
* Wood's Sons Co., T. B.

Pulleys, Paper
Rockwood Mfg. Co.

Pulleys, Steel
* Caldwell & Son Co., H. W.

Pulleys, Wood
* Caldwell & Son Co., H. W.

Pulverized Fuel Feeders
(See Feeders, Pulverized Fuel)

Pulverizers
* Brown Co., A. & F.
* Fuller-Lehigh Co.
Jeffrey Mfg. Co.
Smidth & Co., F. L.
* Williams Patent Crusher & Pulverizer Co.

Pump Governors, Valves, etc.
(See Governors, Valves, etc., Pumps)

Pumping Engines
(See Engines, Pumping)

Pumping Outfits
* Novo Engine Co.

Pumps, Air
Goulds Mfg. Co.
* Westinghouse Elec. & Mfg. Co.

Pumps, Ammonia
* Worthington Pump & Machinery Corpn.

Pumps, Boiler Feed
Goulds Mfg. Co.
* Worthington Pump & Machinery Corpn.

Pumps, Centrifugal
* Allis-Chalmers Mfg. Co.
Goulds Mfg. Co.
* Hunt Machine Co., Rodney
* Lammert & Mann
* Morris Co., I. P.
* Morris Machine Works
* Novo Engine Co.
* Westinghouse Elec. & Mfg. Co.
* Worthington Pump & Machinery Corpn.

Pumps, Deep Well
Goulds Mfg. Co.
* Morris Machine Works
* Novo Engine Co.
* Worthington Pump & Machinery Corpn.

Pumps, Dredging
* Morris Machine Works
* Worthington Pump & Machinery Corpn.

Pumps, Dry Vacuum
(See Pumps, Vacuum)

Pumps, Electric
Goulds Mfg. Co.
* Morris Machine Works
* Worthington Pump & Machinery Corpn.

Pumps, Elevator
* Worthington Pump & Machinery Corpn.

Pumps, Hand
Goulds Mfg. Co.

Pumps, Hydraulic Pressure
Goulds Mfg. Co.
* Morris Machine Works
* Worthington Pump & Machinery Corpn.

Pumps, Oil
Goulds Mfg. Co.
Lunkenheimer Co.
National Supply Cos.
* Novo Engine Co.
* Worthington Pump & Machinery Corpn.

Pumps, Oil, Force-Feed
* Greene, Tweed & Co.
Lunkenheimer Co.

Pumps, Power
Goulds Mfg. Co.
* Novo Engine Co.
* Worthington Pump & Machinery Corpn.

Pumps, Rotary
Goulds Mfg. Co.
* Hunt Machine Co., Rodney
* Lammert & Mann
* Novo Engine Co.

Pumps, Steam
* Worthington Pump & Machinery Corpn.

Pumps, Sugar House
* Worthington Pump & Machinery Corpn.

Pumps, Sump
Goulds Mfg. Co.
* Morris Machine Works
Smidth & Co., F. L.

Pumps, Tank
Goulds Mfg. Co.
* Worthington Pump & Machinery Corpn.

Pumps, Turbine
* General Electric Co.
* Morris Machine Works
* Westinghouse Elec. & Mfg. Co.
* Worthington Pump & Machinery Corpn.

Pumps, Vacuum
Goulds Mfg. Co.
* Lammert & Mann.
* Worthington Pump & Machinery Corpn.

Punches, Hydraulic
* Alliance Machine Co.
Morgan Engineering Co.

Punches, Power
* Royersford Fdry. & Mach. Co.

Punches, Multiple
Mackintosh, Hemphill & Co.

Punches and Dies
* Royersford Fdry. & Mach. Co.

Punching and Shearing Machines
* Alliance Machine Co.
Morgan Engineering Co.
* Royersford Fdry. & Mach. Co.

Purifying and Softening Systems, Water
International Filter Co.
* Scaife & Sons Co., Wm. B.

Pyrometers, Electric
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.
* Taylor Instrument Cos.

Pyrometers, Optical
* Taylor Instrument Cos.

Pyrometers, Radiation
* Taylor Instrument Cos.

Racks, Cut
* James Mfg. Co., D. O.

Racks, Storage, Metal
Manufacturing Equipment & Engrg. Co.

Radiators, Steam and Water
* Smith Co., H. B.

Railways, Cable and Automatic
* Hunt Co., Inc., C. W.

Railways, Industrial
* Hunt Co., Inc., C. W.
* Link-Belt Co.

Rams, Hydraulic
Goulds Mfg. Co.
* Worthington Pump & Machinery Corpn.

Reamers
* Greenfield Tap & Die Corp.

Reamers, Adjustable and Expansion
Kelly Reamer Co.

Receivers, Air
* Scaife & Sons Co., Wm. B.
* Worthington Pump & Machinery Corpn.

Recording Instruments
(See Instruments, Recording)

Refractories
Crescent Refractories Co.

Refrigerating Machinery
* De La Vergne Machine Co.
* Johns-Manville Co., H. W.
* Vilter Mfg. Co.
* Westinghouse Elec. & Mfg. Co.

Refuse Destructors
(See Destructors, Refuse)

Regulators, Blower
Davis Regulator Co., G. M.

Regulators, Damper
Davis Regulator Co., G. M.

Regulators, Electric
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Regulators, Flow (Steam)
Davis Regulator Co., G. M.
Schutte & Koerting Co.

Regulators, Pressure
Davis Regulator Co., G. M.
* Taylor Instrument Cos.

Regulators, Pump
(See Governors, Pump)

Regulators, Temperature
* Foxboro Co.
* Sarco Co., Inc.
* Taylor Instrument Cos.

Regulators, Time
* Foxboro Co.

Reservoirs, Aerating
* Spray Engineering Co.

Revolution Counters
(See Counters, Revolution)

Rings, Weldless Steel
Hay-Budden Mfg. Co.

Riveters, Hydraulic
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.

Riveting Machines
* Bilton Machine Tool Co.

Rods, Fibre
* Continental Fibre Co.
* Diamond State Fibre Co.

Roller Bearings
(See Bearings, Boiler)

Rolling Mill Machinery
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.

Rolls, Crushing
* Worthington Pump & Machinery Corpn.

Rolls, Sand, Chilled and Steel
Mackintosh, Hemphill & Co.

Roofing
* Johns-Manville Co., H. W.
* Texas Co.

Roofing, Asbestos
* Johns-Manville Co., H. W.

Rope Drives
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link Belt Co.
* Wood's Sons Co. T. B.

Rope, Hoisting
* Clyde Iron Works
* Hunt Co., Inc., C. W.
* Roebling's Sons Co., John A.

Rope, Transmission
* Caldwell & Son Co., H. W.
* Hunt Co., Inc., C. W.
* Link-Belt Co.
* Roebling's Sons Co., John A.

Rope, Wire
* Clyde Iron Works
* Roebling's Sons Co., John A.

Rubber Goods, Mechanical
* Jenkins Bros.

Sand Blast Apparatus
* De La Vergne Machine Co.
Lunkenheimer Co.

Sand-Blast Equipment
Pangborn Corporation

Saw and Cutter Sharpeners
* Greenfield Tap & Die Corpn.

Saw Mill Machinery
* Allis-Chalmers Mfg. Co.

Saw Rigs, Portable
* Novo Engine Co.

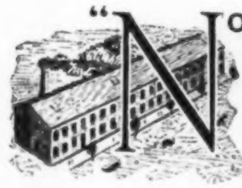
Sawing Machines, Metal
* Greenfield Tap & Die Corpn

Screens, Perforated Metal
Hendrick Mfg. Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1918 Volume*

WORTHINGTON

Keeping ahead of the country



"NOTHING succeeds like success"—this is in brief the story behind each of the plants grouped under the Worthington name.

For each has, through many years, held its own high place in the esteem of American industry; indeed each was called into being by some vital need of industry, and you will find our products in the service of countless important branches of the country's production.

And because our products are such necessary partners in so many and so varied interests, our growth has fairly paralleled the nation's industrial development. From modest beginnings to eight great plants, each both pioneer and leader in its field, each under a common name preserving past traditions of service and satisfaction—this is the concrete measure of Worthington success, and a hint as well of the even larger part to be played in the future.

Works

Worthington Works
Harrison, N. J.

Blake-Knowles Works
East Cambridge, Mass.

Power & Mining Machinery Works
Cudahy, Wis.

Ingeco Engine Works
Cudahy, Wis.

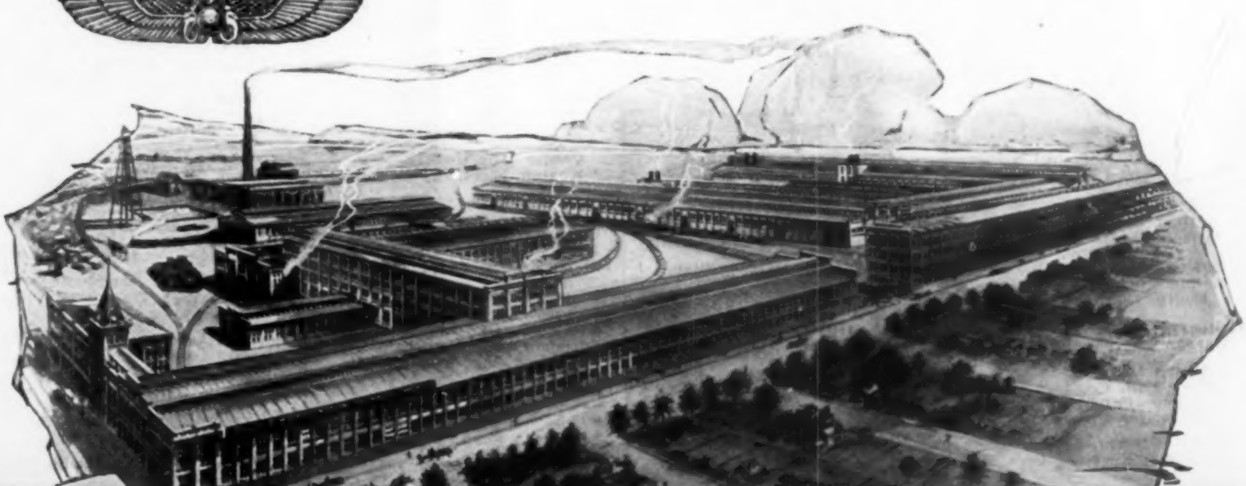
Deane Works
Holyoke, Mass.

Laidlaw Works
Elmwood Place Cincinnati, O.

Snow-Holly Works
Buffalo, N. Y.

Hazleton Works
Hazleton, Pa.

Worthington Pump and Machinery Corporation
115 Broadway, New York City
Branch Offices in 24 Large Cities



LARGEST MAKERS OF PUMPING AND MINING MACHINERY

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) FOR ALPHABETICAL INDEX, SEE PAGE 72

Screens, Revolving
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
Hendrick Mfg. Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
Smidth & Co., F. L.
* Williams Patent Crusher & Pulverizer Co.

Screens, Shaking
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Gifford-Wood Co.
Hendrick Mfg. Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
* Williams Patent Crusher & Pulverizer Co.

Screens, Traveling
* Chain Belt Co.
* Link-Belt Co.

Screw Cutting Dies
(See Dies, Thread Cutting)

Screw Machines, Hand
* Jones & Lamson Mach. Co.
* Warner & Swasey Co.

Screw Plates
* Greenfield Tap & Die Corpn.

Screw Steel
* Union Drawn Steel Co.

Separators, Ammonia
* De La Vergne Machine Co.

Separators, Oil
* Crane Co.
* Harrison Safety Boiler Works
* De La Vergne Machine Co.
* National Pipe Bending Co.

Separators, Steam
* American District Steam Co.
* Crane Co.
* Harrison Safety Boiler Works
* National Pipe Bending Co.
* Pittsburgh Valve Fdry. & Const. Co.

Shafting
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
Cumberland Steel Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
* Union Drawn Steel Co.
* Woods Sons Co., T. B.

Shapes, Cold Drawn Steel
* Union Drawn Steel Co.

Shears, Alligator
Morgan Engineering Co.

Shears, Hydraulic
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.

Shears, Plate
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.

Sheaves, Rope
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Clyde Iron Works
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
Mackintosh, Hemphill & Co.
* Woods Sons Co., T. B.

Sheets, Fibre
* Continental Fibre Co.
* Diamond State Fibre Co.

Shelving, Metal
Manufacturing Equipment & Engrg. Co.

Shipbuilding Machinery
Morgan Engineering Co.

Shredders
Jeffrey Mfg. Co.
* Williams Patent Crusher & Pulverizer Co.

Siphons (Steam-Jet)
Schutte & Koerting Co.

Sirens
(See Whistles, Steam)

Slitting Machines
* Bilton Machine Tool Co.

Sluice Gates
(See Gates, Sluice)

Smoke Recorders
* Sarco Co.

Smoke Stacks and Flues
(See Stacks, Steel)

Sockets, Wire Rope
(See Wire Rope Fastenings)

Soot Blowing Systems
Diamond Power Specialty Co.

Special Machinery
* Brown Co., A. & F.
* Builders Iron Foundry
* Fawcus Machine Co.
* Lammert & Mann
Mackintosh, Hemphill & Co.
Morgan Engineering Co.
* Morris Co., I. P.
Smidth & Co., F. L.
* Vilter Mfg. Co.

Speed Reducing Transmissions
* James Mfg. Co., D. O.
* Poole Engrg. & Mch. Co.

Spouts, Grain
* Caldwell & Son Co., H. W.

Spray Cooling Systems
* Spray Engineering Co.
Star Brass Works

Spray Nozzles
(See Nozzles, Spray)

Sprays, Water
* Spray Engineering Co.

Springs, Coiled
New York Wire & Spring Co.

Springs, Steel
New York Wire & Spring Co.

Springs, Vanadium
New York Wire & Spring Co.

Springs, Wire
New York Wire & Spring Co.

Sprinklers, Spray
* Spray Engineering Co.

Sprockets
* Baldwin Chain & Mfg. Co.
* Caldwell & Son Co., H. W.
* Chain Belt Co.
* Fuller-Lehigh Co.
Gifford-Wood Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
* Link-Belt Co.

Stacks, Steel
* Bigelow Co.
* Casey-Hedges Co.
* Cole Mfg. Co., R. D.
* Heine Safety Boiler Co.

Standpipes
* Cole Mfg. Co., R. D.

Steam Engines, Separators, Shovels, Superheaters, Traps, Turbines, etc.
(See Engines, Separators, Shovels, Superheaters, Traps, Turbines, etc., Steam)

Steam Specialties
* American District Steam Co.
* Crane Co.
Davis Regulator Co., G. M.
Lunkenheimer Co.
* Pittsburgh Valve Fdry. & Const. Co.
* Sarco Co., Inc.

Steel, Alloy
* Union Drawn Steel Co.

Steel, Bright Finished
* Union Drawn Steel Co.

Steel, Cold Drawn
* Union Drawn Steel Co.

Steel, Cold Rolled
Cumberland Steel Co.
* Union Drawn Steel Co.

Steel, Nickel
* Union Drawn Steel Co.

Steel, Open Hearth
* Union Drawn Steel Co.

Steel, Vanadium
* Union Drawn Steel Co.

Steering Engines
(See Engines, Steering)

Steel Plate Construction
* Bigelow Co.
* Casey-Hedges Co.
* Cole Mfg. Co., R. D.
* Heine Safety Boiler Co.
* Hunt Machine Co., Rodney

Stills, Water
* Hodges Water Still Co., Inc.

Stocks and Dies
* Greenfield Tap & Die Corpn.
* Landis Machine Co., Inc.

Stokers, Chain Grate
* Babcock & Wilcox Co.
Combustion Engineering Corpn.
* Green Engineering Co.
Illinois Stoker Co.
* Westinghouse Elec. & Mfg. Co.

Stokers, Overfeed
* Murphy Iron Works
* Westinghouse Elec. & Mfg. Co.

Stokers, Underfeed
American Engineering Co.
Combustion Engineering Corpn.
* Riley Stoker Co., Ltd., Sanford.
* Westinghouse Elec. & Mfg. Co.

Stools and Chairs, Metal
Manufacturing Equipment & Engrg. Co.

Strainers, Water
* Pittsburgh Valve Fdry. & Const. Co.
Schutte & Koerting Co.

Strainers, Water, Traveling
* Chain Belt Co.
* Link-Belt Co.

Structural Steel Work
Hendrick Mfg. Co.
Toledo Bridge & Crane Co.

Sugar Machinery
Hooven, Owens, Rentschler Co.

Superheaters, Steam
* Babcock & Wilcox Co.
* Heine Safety Boiler Co.

Switchboards
* General Electric Co.
Sprague Electric Works
* Westinghouse Elec. & Mfg. Co.

Switches, Electric
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Synchronous Converters
(See Converters, Synchronous)

ables, Drawing
New York Blue Print Paper Co.

Tachometers
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.
* Weston Electrical Instrument Co.

Tackle Blocks
(See Blocks, Tackle)

Tank Work (Air, Gas, Oil, Water)
* Bigelow Co.
* Casey-Hedges Co.
* Cole Mfg. Co., R. D.
* Heine Safety Boiler Co.
* Scaife & Sons Co., Wm. B.

Tanks, Storage
* Cole Mfg. Co., R. D.
* Harrison Safety Boiler Works
* Scaife & Sons Co., Wm. B.

Tanks, Welded
* Cole Mfg. Co., R. D.
* Scaife & Sons Co., Wm. B.

Taps and Dies
* Greenfield Tap & Die Corpn.

Telescopic Oilers
(See Oilers, Telescopic)

Temperature Regulators
(See Regulators, Temperature)

Testing Laboratories, Cement
Smidth & Co., F. L.

Testing Laboratories, Electrical
Electrical Testing Laboratories

Textile Wet Finishing Machinery
* Hunt Machine Co., Rodney

Thermometers
* Ashton Valve Co.
* Foxboro Co.
* Schaeffer & Budenberg Mfg. Co.
* Taylor Instrument Cos.

Thermometers, Distance
* Foxboro Co.
* Taylor Instrument Cos.

Thermometers, High Range
* Taylor Instrument Cos.

Thread Cutting Tools
* Crane Co.
* Landis Machine Co., Inc.
* Jones & Lamson Machine Co.
* Greenfield Tap & Die Corpn.

Threading Machines, Pipe
* Landis Machine Co., Inc.

Time Controllers
(See Regulators, Time)

Time Recorders
* Foxboro Co.

Tipples, Steel
Jeffrey Mfg. Co.
* Link-Belt Co.

Tools, Boring
Lovejoy Tool Co., Inc.

Tools, Boring, Adjustable
Kelly Reamer Co.

Tools, Brass-Working Machine
* Warner & Swasey Co.

Tools, Lathe
Lovejoy Tool Co., Inc.

Tools, Machinist's Small
* Atlas Ball Co.

Torches, Hand
* Best, W. N.

Track, Industrial
* Hunt Co., Inc., C. W.
Northern Engineering Works

Tractors
* Allis-Chalmers Mfg. Co.

Tramrail Systems, Overhead
* Brown Hoisting Machinery Co.
* Ford Chain Block & Mfg. Co.
* Link-Belt Co.
Northern Engineering Works
* Shepard Electric Crane & Hoist Co.
Sprague Electric Works

Tramways, Bridge
* Brown Hoisting Machinery Co.
* Hunt Co., Inc., C. W.
* Link-Belt Co.
Toledo Bridge & Crane Co.

Tramways, Wire Rope
* Clyde Iron Works
* Roebling's Sons Co., John A.
* Lidgerwood Mfg. Co.

Transformers, Electric
* General Electric Co.
* Westinghouse Elec. & Mfg. Co.

Transmission Machinery
(See Power Transmission Machinery)

Transmissions, Automobile
Grant-Lees Gear Co.

Traps, Return
* American Blower Co.
* Crane Co.

Traps, Steam
* American Blower Co.
* American District Steam Co.
* Crane Co.
Davis Regulator Co., G. M.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1918 Volume*

MEMBERS' EXCHANGE

Classified advertisements in The Journal of The American Society of Mechanical Engineers are inserted at the rate of 10 cents a line to members and 20 cents a line to non-members. Seven words to the line average. Minimum insertion charge, 5 line basis; maximum 20 lines. No display matter carried.

Copy must be in hand not later than the 15th of the month preceding date of publication.

I desire to invest money and enter business with a consulting engineer or small concern in the middle west. Prefer power plant work. Address EX 173, care this Journal.

MANUFACTURERS—HAVE YOU A NEW YORK OFFICE? Established machinery concern, with sales and engineering organization, wishes to add new lines of reliable machinery, mechanical equipment or specialties. On the ground for New York district and export trade. If you are not represented in New York—Write us. Box EX 172.

THE BEST WAY TO GET A GOOD POSITION IN drafting or engineering is to file an application direct with some of our clients who are depending on us to get competent and experienced applicants for their openings. The Cleveland Engineering Agency Co., Rose Building, Cleveland, O.

Mechanical and engineering DRAFTING WORK. On contract or per hour basis. "Overloaded drafting departments"; it will pay you to investigate this advertisement. Address E. G. Allen, 173 W. Seymour Street, Philadelphia, Pa.

FOR SALE—Complete Set of Transactions—New—$4.00 per volume. Address F. A. Johnson, Box 1185, New Haven, Conn.

PROFESSIONAL OPENING. We are desirous of adding to our Staff, men qualified by education, training and experience to undertake industrial-engineering-production problems.

Our clients represent some of the largest firms in the country.

We require men of unquestioned integrity and industry, possessing strong pleasing personalities; who are forceful, yet tactful; with it all patient.

Our problems cover investigations and analyzing industrial shortcomings; reorganizing plant and personnel; devising simple comprehensive cost-production-accounting records; planning and scheduling operations; coordinating plant details; standardizing methods and shop practice; installing proper incentives and rewards, etc., etc.

Permanent association for men producing results and satisfying clients.

C. E. Knoeppel & Co., 101 Park Avenue, N. Y. City.

PATENTED DEVICE—Would be pleased to consider purchase or manufacture on royalty of metal patented device, machine tool or machine part, having sufficient apparent merit as a commercial proposition to warrant investigation and investment.

Machine shop fully equipped and organized for rapid production of duplicate parts. Address L. J. Schuyler, 615 Euclid Ave., Syracuse, N. Y.

TIME SAVING CALIPERS. I have a patent on an inside caliper that gives the diameter of circular stock necessary to make hexagons and squares. Also patent allowed on an attachment for outside calipers that gives the size drill to use when the hole is to be tapped for bolt or pipe threads.

I should like to get in touch with reliable firm with a view to placing these patents on the market. R. L. Mossman, Box 145, Humboldt, Tenn.

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